



DEPARTMENT OF TOXIC
SUBSTANCES CONTROL

DEC 17 2011

POLLUTION PREVENTION
& GREEN TECHNOLOGY

Sang-Tae Kim
Manager
Design-for-Environment /
Global Product Stewardship
Environmental, Health and
Safety Department

December 15, 2011

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Foster City, CA 94404
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Mr. Donald Owen
Department of Toxic Substances Control
1001 "I" Street
P.O. Box 806
Sacramento, CA 95812-0806

**Re: Request for Chemical Information and Analytical Test
Methods for Quantum Dots**

Dear Mr. Owen,

This letter is in response to the Department of Toxic Substances Control (DTSC)'s December 21, 2010 call-in letter to Life Technologies requesting chemical information and analytical test methods for our Qdot® (Quantum Dot) products. Life Technologies has received two DTSC call-in letters dated on December 21, 2010. One letter was addressed to Mr. Farnaz Khadem in Carlsbad, while the other letter was addressed to me in Foster City. I am collectively responding on behalf of Life Technologies.

Created from the merger between Invitrogen and Applied Biosystems in 2008, Life Technologies manufactures Qdot® products at a facility in Oregon and imports them into California. The total annual production volume in Oregon is approximately 15 grams. The quantity of Qdot® products imported into California is less than 1 gram per year. Our Qdot® products are mostly purchased by universities and research institutes as research and development-use materials, typically in quantities of less than 1 milligram. Currently, we are importing and/or selling 145 different Qdot® products into/in California. These Qdot® products

can be categorized into 12 different products based on core, shell, surface coating, size and shape:

1. Qdot® ITK™ Carboxyl Quantum Dots
2. Qdot® Antibody Conjugate
3. Qdot® Streptavidin Conjugate
4. WesternDot® Western Blot Kit
5. Qtracker® Cell Labeling Kit
6. Qdot® ITK™ Streptavidin Conjugate Kit
7. Qdot® ITK™ organic Quantum Dots
8. Qdot® Antibody Conjugation Kit
9. Qdot® ITK™ Amino (PEG) Quantum Dots
10. Qdot® Biotin Conjugate Kit
11. Qtracker® Non-targeted Quantum Dots
12. Qdot® Dipeptide Quantum Dots (custom synthesis)

Life Technologies' responses to DTSC's questions for each Quantum Dot product category are enclosed.

If you require any additional information, please do not hesitate to contact me at 650-554-2798 or sang-tae.kim@lifetech.com.

Sincerely,



Sang-Tae Kim, Ph.D., DABT
Manager, Design-for-Environment
EHS/Global Product Stewardship

Enclosures

Cc: C. Amorim, Life Technologies
D. Seid, Life Technologies
J. Barreno, Life Technologies

STATE OF CALIFORNIA
Department of Toxic Substances Control

Health and Safety Code Section 57019 Chemical Information Call-in Information
For Nanometals, Nanometal Oxides, and Quantum Dots
December 2010

This enclosure is provided for your convenience. You may provide the requested information in writing, and attaching any supplementary materials or explanatory information, in letter or report form.

SECTION A: CHEMICAL(S) (Check each one which applies for your company)		
<input type="checkbox"/> Nano Silver	<input type="checkbox"/> Nano Titanium Dioxide	<input type="checkbox"/> Nano Cerium Oxide
<input type="checkbox"/> Nano Zero Valent Iron	<input type="checkbox"/> Nano Zinc Oxide	<input checked="" type="checkbox"/> Quantum Dot(s)

SECTION B: BUSINESS IDENTIFICATION INFORMATION (check one and complete 1 - 10)				
<input type="checkbox"/> Sole Owner	<input checked="" type="checkbox"/> Corporation	<input type="checkbox"/> Limited Liability Company (LLC)	<input type="checkbox"/> Limited Liability Partnership (LLP)	<input type="checkbox"/> Unincorporated Business Trust
<input type="checkbox"/> Spouses' Co-ownership	<input type="checkbox"/> Registered Domestic Partnership	<input type="checkbox"/> General Partnership	<input type="checkbox"/> Limited Partnership	<input type="checkbox"/> Other: (describe)
1. <i>Name of Sole Owner, Corporation, Partnership, Institute, Other.</i> Life Technologies Corporation				
2. <i>Business Trade Name ("Doing Business As," if any)</i> None				
3. <i>Business Address (physical location of your business: street number and name, city, state, country, zip or postal code)</i> 5791 Van Allen Way, Carlsbad, California 92008, USA				
4. <i>Mailing Address (street name and number, P.O. box, city, state, country, zip or postal code, if different from 3)</i> The Same as Above				
5. <i>Business Website Address(es):</i> http://www.lifetechnologies.com				
6. <i>Name of Owner, Responsible Corporate Officer, Partner, Other.</i> Sang-Tae Kim				
7. <i>Contact Information for Person in 6 above.</i>				
Name: Sang-Tae Kim		Title: Manager, Design-for-Environment/EHS		
Business Telephone: 650-554-2798		Email: sang-tae.kim@lifetech.com		
8. <i>Number of Employees (California employees).</i> 2908				
9. <i>NAICS Code(s) for this business:</i>		Primary: 325413	Other:	Other:
10. <i>Nano Chemical Business Type: (check applicable)</i>		<input checked="" type="checkbox"/> Manufacturer	<input checked="" type="checkbox"/> Importer	<input checked="" type="checkbox"/> Researcher

SECTION C: CERTIFICATION (FOR THIS COMPLETE SUBMITTAL)		
I am fully authorized to prepare and submit this information, as a formal response to the request pursuant to Health and Safety Code section 57019(d)(1), and certify the information and statements made herein, and in the attachments, are correct to the best of my knowledge and belief.		
Name: (type or print) Sang-Tae Kim	Signature: 	Date: December 15, 2011

SECTION D: NANOMATERIAL CHEMICAL AND PHYSICAL PROPERTIES (Attach additional pages as needed)		
PRODUCT / PRODUCTION INFORMATION		
NANO CHEMICAL NAME: Qdot® ITK carboxyl quantum dots		
COMMERCIAL NAME(S): Qdot® 525 ITK carboxyl quantum dots, Qdot® 545 ITK carboxyl quantum dots, Qdot® 565 ITK carboxyl quantum dots, Qdot® 585 ITK carboxyl quantum dots, Qdot® 605 ITK carboxyl quantum dots, Qdot® 625 ITK carboxyl quantum dots, Qdot® 655 ITK carboxyl quantum dots, Qdot® 705 ITK carboxyl quantum dots, Qdot® 800 ITK carboxyl quantum dots		
ANNUAL PRODUCTION VOLUME: Total annual production is 4.046 grams. Quantity shipped to California is 0.249 gram.		
PRODUCTION METHOD(S): Core and core-shell nanoparticles are produced using common colloidal synthesis techniques. Some examples may be found in the following patents: 6,322,901; 6,815,064; 7,147,712; 7,695,642. Some examples of methods for applying the amphiphilic coating to these particles to render them water soluble may be found in the following patent 6,649,138.		
IDENTIFICATION OF THE SUPPLIER(S): Life Technologies is the producer and supplier of these products.		
PARAMETER	VALUE / RANGE	NAME OF ANALYTICAL METHOD(S)
PHYSICAL PROPERTIES		
SHAPE (MORPHOLOGY)	The morphology of a nanoparticle is most commonly measured by transmission electron microscopy (TEM) since it is the only analytical technique with resolution sufficient to resolve the fine features of a nanoparticle. This technique is limited, however, since it is most sensitive to electron dense elements of the nanoparticle like cadmium, zinc and selenium and virtually insensitive to lighter elements like carbon, hydrogen, oxygen and nitrogen. This means that shape and morphology information is not available for nanoparticles that comprise organic coatings. In other words, TEM can only give you information about the nanocrystal within a nanoparticle. TEM is further limited by the fact that the data acquired is only a two dimensional projection of the three dimensional shape. Therefore to calculate the volume or surface area, a three dimensional shape must be assumed. The size of the nanoparticle (nanocrystal and organic ligands) can be measured by size exclusion chromatography (SEC) but this technique does not have the resolution to provide morphology information.	See Attachment 1
DENSITY	The density of these materials has not been measured	
SURFACE AREA	Since we cannot measure the morphology of ITK carboxyl quantum dot nanoparticles, we cannot calculate the surface area. If we approximate the morphology as a sphere and use the SEC sizing data, we can calculate a spherical surface area.	See Attachment 1
PARTICLE SIZE DISTRIBUTION	Air	To the best of our knowledge, no technique is currently available
	Liquid	Dynamic light scattering can give particle size distribution data, however, several complications exist in interpreting the data. Some of those caveats include, (1) since quantum dots have broad absorbance, any color that emits at longer wavelengths than the laser will absorb some of the laser light and make interpretation of the data nearly impossible, (2) large particles scatter much more efficiently than smaller particles making detection of small particle populations difficult.
	Solid/ Powder	To the best of our knowledge, no technique is currently available
OTHER (SPECIFY)		
CHEMICAL PROPERTIES		
CHEMICAL COMPOSITION	The inorganic portion of the nanoparticles (nanocrystal) is	The chemical

		composed of cadmium, selenium, zinc and sulfur. Two of our nanocrystal products (Qdot 705 and 800) additionally contain tellurium. The exact composition of the ligand shell is unknown but NMR has revealed that it is mostly composed of tetradecylphosphonic acid (TDPA) and/or other phosphorus-containing species. The polymer coating is an amphiphilic molecule that is associated with the nanoparticle and provides water solubility.	composition of this polymer is best described in Patent Number 6,649,138
SURFACE MODIFICATION (COATING, FUNCTIONALIZATION)		The outer surface contains an amphiphilic polymer.	The process of applying this polymer to the nanoparticles is best described in patent number 6,649,138.
PURITY		Purity is essential for our products. We have most routinely use SEC to detect and measure impurities. Some of those impurities include aggregated nanoparticles, free (unbound) amphiphilic polymer, and other nanoparticle impurities.	See Attachment 2
SURFACE CHARGE		We routinely perform gel electrophoresis to confirm the charge of a particle but we do not quantitate it in terms of charge density.	See Attachment 3
DISPERSION	Air	We do not handle air dispersions in our operations or R&D	
	Liquid	Presence of aggregated particles is routinely measured by SEC chromatography. In fact, all of our products and water soluble intermediates have specifications around the percentage of these soluble aggregates present in the solution.	
	Solid	We do not handle the materials in the solid form, but as a liquid dispersion.	
IDENTIFYING AND DETERMINING CONCENTRATION OF NANO CHEMICAL, ITS METABOLITES, AND DEGRADATION PRODUCTS IN SPECIFIED MATRICES (Water, Air, Soil, Sediment, Sludge, Chemical Waste, Fish, Blood, Adipose Tissue, Urine, Other)		Determining the exact concentration of nanoparticles in any matrix is difficult because routine nanoparticle counting techniques do not currently exist. The most common method for determining the concentration of quantum dots is to measure the optical absorbance in solution at a concentration where Beer's law is operative and calculate the concentration using an estimated extinction coefficient for the material.	A example of a common technique for estimating the extinction coefficient for quantum dot can be found in this reference (Chem. Mater. 2003, 15, 2854-2860)
SOLUBILITY	Water Solubility	Soluble/miscible in water. These products are sold at a concentration of 8 micromolar which is in the range of 0.5 mg/mL to 8 mg/mL depending on the color.	
	Solubility in Organic Solvent	Not soluble/miscible in organic solvent	
N-OCTANOL-WATER PARTITION COEFFICIENT		We have not measured this parameter.	
STABILITY AND REACTIVITY	Flammability	These nanoparticle products are sold as dilute (8 µM or approximately 0.5 mg to 8 mg/mL) aqueous solutions and are therefore classified with a HMIS flammability rating of 0 (same as water).	
	Explosiveness	These products do not pose an explosion hazard. This conclusion is partially based on thermogravimetric analysis (TGA) of our ITK organic quantum dots. TGA shows that no weight loss occurs until about 300 °C. At around 300 °C the particles lose about 10 - 20 % of their mass. This temperature coincides with the boiling point of the organic ligands used in the synthesis of quantum dots. No other weight loss is observed up to a temperature of 650 °C.	See Attachment 4

	Oxidizing Properties	These products are not strong oxidizing agents.	
	Oxidation Reduction Potential	These products are not strong reducing agents.	
	Storage Stability and Reactivity (Container Material)	These products are stable in a variety of container materials including, glass and plastic. The product is packaged and shipped in polypropylene vials.	
	Stability to Thermal, Sunlight, and Metal(s)	These products are stable, meaning that they will work for their intended purpose, to multiple rounds of freezing and thawing and moderately high temperatures (0 °C to 37 °C). These products are stable and will work for their intended purpose with moderate sunlight exposure. Some metals will quench the fluorescence from these particles. Particularly copper (II) and iron (III).	Reference - Cytometry Part A, 79A: 84 89, 2011

SECTION E: Provide a copy of your Globally Harmonized System (GHS) Safety Data Sheet (SDS), if you have prepared one.

Attached is current SDS/Material Safety Data Sheet (MSDS). See Attachment 5

SECTION F: For each nanomaterial you produce or import, describe the analytical test method(s) that you use, or plan to use, to sample, prepare, and analyze a specific matrix to determine the identity and concentration of each specified nanomaterial. Use a separate page to describe the procedure for each, individual matrix, which must include water, air, soil, sediment, sludge, chemical waste, fish, blood, adipose tissue, and urine. Include the information requested in Section D above.

Life Technologies' *Medical Surveillance and Monitoring Plan* requires a bi-annual monitoring of blood and urine samples as well as an annual physical examination of employees who are involved in manufacturing of quantum dots. No cadmium was detectable from either blood or urine samples, when analyzed with the use of Inductively Coupled Plasma/Mass Spectrometry (ICP-MS) (see <http://www.aruplab.com/guides/ug/tests/0025040.jsp> for detailed information on sampling and analysis methodology).

We have not determined the identity and concentration of Qdot® ITK carboxyl quantum dots in environmental matrix including air, soil, sediment, sludge, chemical waste, fish, and adipose tissue. However, there is a report that looked at the effect of commercially available Qdot® 545 ITK carboxyl quantum dots on the freshwater alga *Pseudokirchneriella subcapitata* and the cladoceran *Ceriodaphnia dubia* (Jennifer L. Bouldin, Taylor M. Ingle, Anindita Sengupta, Regina Alexander, Robyn E. Hannigan, Roger A. Buchanan; *Environmental Toxicology and Chemistry*, 2008, 1958-1963). These model organisms are well established model species in standard toxicological and ecological risk assessments and judged to provide a simple model for food chain transfer. In this study, the authors found that these aquatic organisms exposed to Qdot® 545 ITK carboxyl quantum dots were able to withstand concentrations of cadmium that were 500-fold or greater higher than was the case for bulk cadmium. This result is contrary to the widely held view that nanoforms of toxic materials, in this case, cadmium, are likely to have toxicological effects at lower concentrations due to their high surface area. Because in Qdot® 545 ITK carboxyl quantum dots, the cadmium is encapsulated by a shell substance, the nanofom of this substance appears to be overall less toxic than its bulk counterpart.

ATTACHMENT 1

Particle Size Morphology of Qdot ITK Carboxyl Quantum Dots

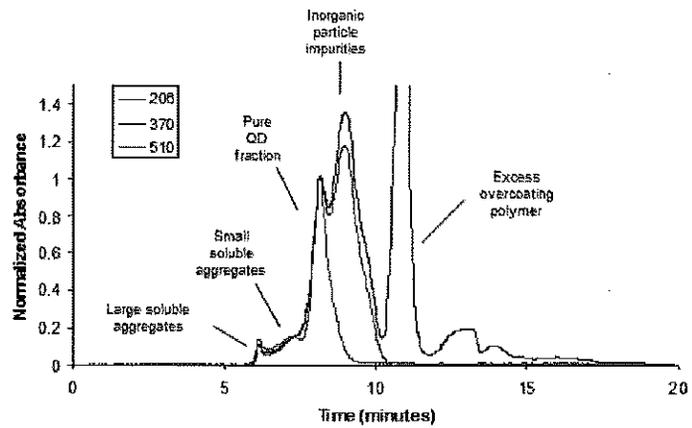
Particle Size and Morphology - ITK Carboxyl Quantum Dots				
Emission Wavelength (nm)	diameter (nm)	3D shape (assumption)	volume (nm ³)	surface area (nm ²)
525	13.1	sphere	1180	540
545				
565	13.1	sphere	1181	540
585	13.4	sphere	1249	561
605	15.2	sphere	1854	730
625				
655	15.9	sphere	2124	799
705	16.2	sphere	2215	822
800	16.3	sphere	2270	835

Note: Particle diameters were acquired by size exclusion chromatography (SEC). Since SEC cannot resolve morphology, we are assuming a sphere for the purpose of calculating the volume and surface area.

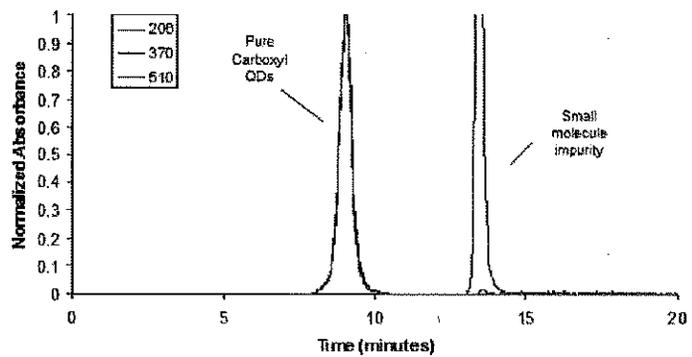
ATTACHMENT 2

Purity of Qdot ITK Carboxyl Quantum Dots by Size Exclusion Chromatography

Chromatogram of *unpurified* sample



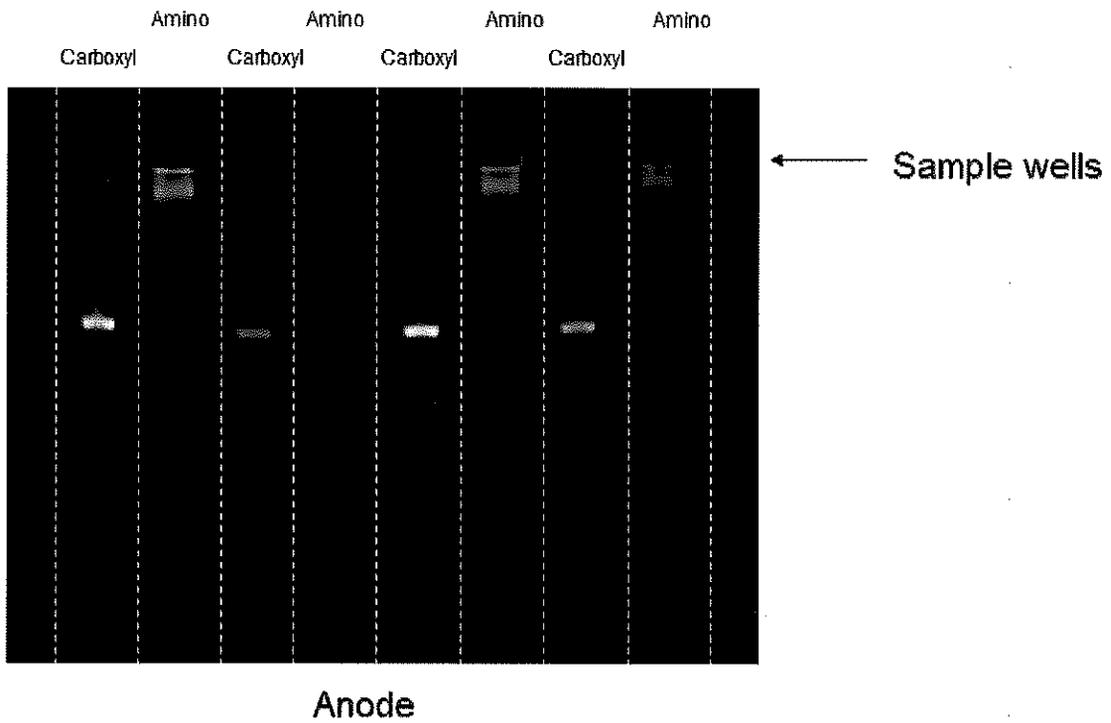
Chromatogram of *purified* sample



Note: Small molecule impurity is removed in later step.

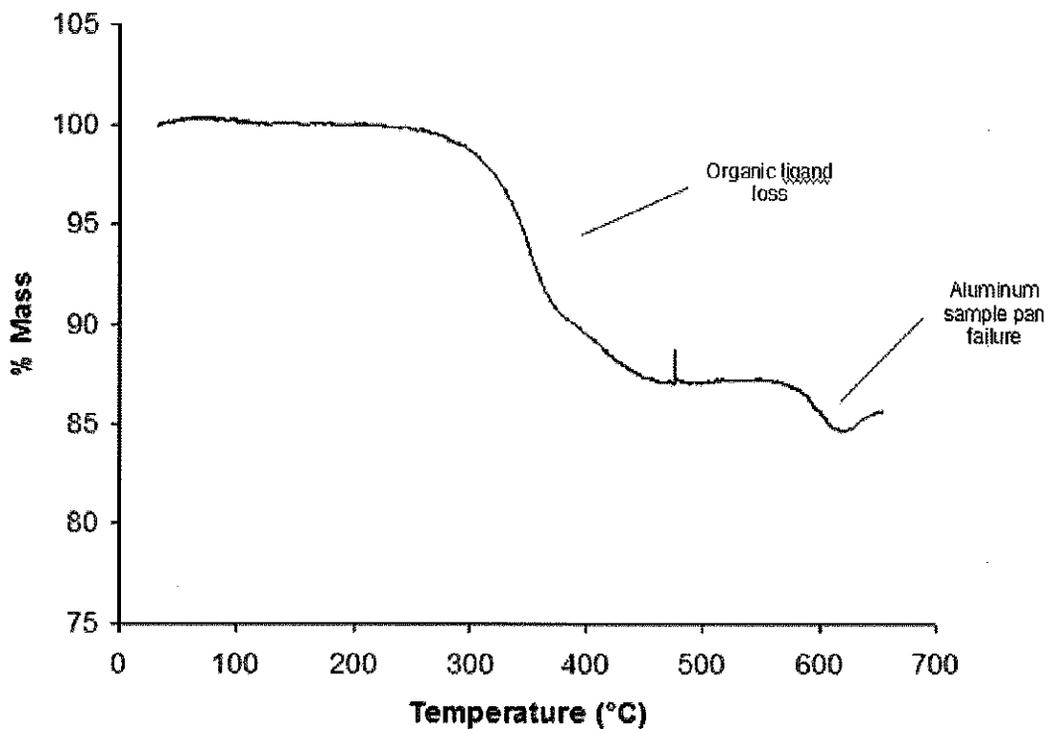
ATTACHMENT 3

E-Gel® Precast Agarose Gel



ATTACHMENT 4

Thermogravimetric Analysis of Qdot ITK Carboxyl Quantum Dots



ATTACHMENT 5
MATERIAL SAFETY DATA SHEET
(Sample)



SAFETY DATA SHEET

1. Identification of the substance/mixture and of the company/undertaking

Identification of the substance/preparation

Product code Q21341MP
Product name Qdot® 525 ITK™ carboxyl quantum dots *8 µM solution*

Company/Undertaking Identification

Life Technologies
5791 VAN ALLEN WAY
PO BOX 6482
CARLSBAD, CA 92008
+1 760 603 7200

INVITROGEN CORPORATION
5250 MAINWAY DRIVE
BURLINGTON, ONT
CANADA L7L 6A4
800/263-6236

24 hour Emergency Response (Transport): 866-536-0631
301-431-8585
Outside of the U.S. +1-301-431-8585

For research use only. Not intended for human or animal diagnostic or therapeutic uses.

Revision Date 29-Nov-2011
Product code Q21341MP

Product name Qdot® 525 ITK™ carboxyl quantum dots *8 µM solution* **Page 1 / 6**

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2. Hazards identification

GHS - Classification

Signal Word
not hazardous

Health Hazard
not hazardous

Physical Hazards
not hazardous

**Principle Routes of Exposure/
Potential Health effects**

Eyes	May cause eye irritation with susceptible persons.
Skin	May cause skin irritation in susceptible persons.
Inhalation	May be harmful by inhalation.
Ingestion	May be harmful if swallowed.

Specific effects

Carcinogenic effects	none.
Mutagenic effects	none.
Reproductive toxicity	none.
Sensitization	none.

Target Organ Effects No known effects under normal use conditions

HMIS

Health	0
Flammability	0
Reactivity	0

3. Composition/information on ingredients

The product contains no substances which at their given concentration, are considered to be hazardous to health. We recommend handling all chemicals with caution.

4. First aid measures

Revision Date 28-Nov-2011
Product code Q21341MP

Product name Qdot® 525 ITK™ carboxyl quantum dots '8 µM solution'

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Skin contact	Rinse with plenty of water. If symptoms arise, call a physician.
Eye contact	Rinse immediately with plenty of water, also under the eyelids, for at least 15 minutes. If symptoms persist, call a physician.
Ingestion	Never give anything by mouth to an unconscious person. If symptoms persist, call a physician. Do not induce vomiting without medical advice.
Inhalation	Move to fresh air. If symptoms persist, call a physician. If not breathing, give artificial respiration.
Notes to physician	Treat symptomatically.

5. Fire-fighting measures

Suitable extinguishing media	Water spray. Carbon dioxide (CO ₂). Foam. Dry chemical.
Special protective equipment for firefighters	Wear self-contained breathing apparatus and protective suit.

6. Accidental release measures

Personal precautions	Use personal protective equipment.
Methods for cleaning up	Soak up with inert absorbent material.

Environmental precautions

Prevent further leakage or spillage if safe to do so.

See Section 12 for additional information.

7. Handling and storage

Handling	Always wear recommended Personal Protective Equipment. No special handling advice required.
Storage	Keep in a dry, cool and well-ventilated place.

8. Exposure controls/personal protection

Exposure limits

At this time, the limited evidence available suggests caution when potential exposures to nanoparticles may occur. Due to the limited information about health risks from nanomaterials, it is prudent to take steps for minimizing worker exposures. Research is still needed to understand the impact of nanotechnology on health, and to determine appropriate exposure monitoring and control strategies.

<u>Engineering measures</u>	Ensure adequate ventilation, especially in confined areas.
------------------------------------	--

Personal protective equipment

Respiratory protection	In case of insufficient ventilation wear suitable respiratory equipment.
Hand protection	Impervious gloves.
Eye protection	Safety glasses with side-shields.
Skin and body protection.	Lightweight protective clothing.
Hygiene measures	Handle in accordance with good industrial hygiene and safety practice.

Revision Date 29-Nov-2011
Product code Q2134IMP

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Product name Qdot® 525 ITK™ carboxyl quantum dots "8 µM solution"

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Environmental exposure controls Prevent product from entering drains.

9. Physical and chemical properties

General Information

Form	suspension	
Appearance	liquid	
Odor	No information available	
Boiling Point/Range	°C no data available	°F no data available
Melting point/range	°C no data available	°F no data available
Flash point	°C no data available	°F no data available
Autoignition temperature	°C no data available	°F no data available
Oxidizing properties	No information available.	
Water solubility	soluble	
pH VALUE	9	

10. Stability and reactivity

Stability	Stable under normal conditions.
Materials to avoid	No dangerous reaction known under conditions of normal use.
Hazardous decomposition products	None under normal use
polymerization	Hazardous polymerisation does not occur.

11. Toxicological information

Acute toxicity

At this time, the limited evidence available suggests caution when potential exposures to nanoparticles may occur. Due to the limited information about health risks from nanomaterials, it is prudent to take steps for minimizing worker exposures. Occupational health risks associated with manufacturing and using nanomaterials are not yet clearly understood. Studies have indicated that low solubility nanoparticles are more toxic than larger particles on a mass for mass basis. There are strong indications that particle surface area and surface chemistry are responsible for observed responses in cell cultures and animals. There are indications that nanoparticles can penetrate through the skin or move from the respiratory system to other organs.

Principle Routes of Exposure/

Potential Health effects

Eyes	May cause eye irritation with susceptible persons.
Skin	May cause skin irritation in susceptible persons.
Inhalation	May be harmful by inhalation.
Ingestion	May be harmful if swallowed.
Carcinogenic effects	none
Mutagenic effects	none
Reproductive toxicity	none
Sensitization	none
Target Organ Effects	No known effects under normal use conditions

Revision Date 29-Nov-2011
 Product code Q21341MP

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 Product name Qdot® 525 ITK™ carboxyl quantum dots *8 µM solution*

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12. Ecological information

Ecotoxicity effects	No information available.
Mobility	No information available.
Biodegradation	inherently biodegradable
Bioaccumulation	Does not bioaccumulate.

13. Disposal considerations

Dispose of in accordance with local regulations.

14. Transport information

IATA

Proper shipping name	Not classified as dangerous in the meaning of transport regulations
Hazard class	none
Subsidiary Class	none
Packing group	none
UN-No	None

15. Regulatory information

U.S. Federal Regulations

SARA 313

This product contains the following toxic chemical(s) subject to the notification requirements of section 313 of Title III of the Superfund Amendments and Reauthorization Act of 1986. This law requires certain manufacturers to report on annual emissions of specified chemicals and chemical categories. Please note that if you repackage, or otherwise redistribute, this product to industrial customers, a notice similar to this one should be sent to those customers:

Clean Air Act, Section 112 Hazardous Air Pollutants (HAPs) (see 40 CFR 61)

This product does not contain HAPs.

U.S. State Regulations

California Proposition 65

This product does not contain chemicals listed under Proposition 65

WHMIS hazard class:

Non-controlled

This product has been classified according to the hazard criteria of the CPR and the MSDS contains all of the information required by the CPR

16. Other information

Reason for Revision (M)SDS sections updated.

Revision Date 29-Nov-2011
Product code Q21341MP

Page 5 / 8
Product name Qdot® 525 ITK™ carboxyl quantum dots "8 µM solution"

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For research use only. Not intended for human or animal diagnostic or therapeutic uses.

References

- National Institute for Occupational Safety and Health (NIOSH), U.S., 2010:
<http://www.cdc.gov/niosh/topics/nanotech/>
- National Institute for Occupational Safety and Health (NIOSH), U.S., 2009:
<http://www.cdc.gov/niosh/docs/2009-125/pdfs/2009-125.pdf>

The above information was acquired by diligent search and/or investigation and the recommendations are based on prudent application of professional judgment. The information shall not be taken as being all inclusive and is to be used only as a guide. All materials and mixtures may present unknown hazards and should be used with caution. Since the Company cannot control the actual methods, volumes, or conditions of use, the Company shall not be held liable for any damages or losses resulting from the handling or from contact with the product as described herein. THE INFORMATION IN THIS MSDS DOES NOT CONSTITUTE A WARRANTY, EXPRESSED OR IMPLIED, INCLUDING ANY IMPLIED WARRANTY OF MERCHANTABILITY OR FITNESS FOR ANY PARTICULAR PUPOSE.

End of Safety Data Sheet

Revision Date 29-Nov-2011
Product code Q2134IMP

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Product name Qdot®525 ITK™ carboxyl quantum dots *8 µM solution*

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STATE OF CALIFORNIA
Department of Toxic Substances Control

Health and Safety Code Section 57019 Chemical Information Call-in Information
For Nanometals, Nanometal Oxides, and Quantum Dots
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<input type="checkbox"/> Spouses' Co-ownership	<input type="checkbox"/> Registered Domestic Partnership	<input type="checkbox"/> General Partnership	<input type="checkbox"/> Limited Partnership	<input type="checkbox"/> Other: (describe)
1. Name of Sole Owner, Corporation, Partnership, Institute, Other. Life Technologies Corporation				
2. Business Trade Name ("Doing Business As," if any) None				
3. Business Address (physical location of your business: street number and name, city, state, country, zip or postal code) 5791 Van Allen Way, Carlsbad, California 92008, USA				
4. Mailing Address (street name and number, P.O. box, city, state, country, zip or postal code, if different from 3) The Same as Above				
5. Business Website Address(es): http://www.lifetechnologies.com				
6. Name of Owner, Responsible Corporate Officer, Partner, Other. Sang-Tae Kim				
7. Contact Information for Person in 6 above.				
Name: Sang-Tae Kim		Title: Manager, Design-for-Environment/EHS		
Business Telephone: 650-554-2798		Email: sang-tae.kim@lifetech.com		
8. Number of Employees (California employees). 2908				
9. NAICS Code(s) for this business:		Primary: 325413	Other:	Other:
10. Nano Chemical Business Type: (check applicable)		<input checked="" type="checkbox"/> Manufacturer	<input checked="" type="checkbox"/> Importer	<input checked="" type="checkbox"/> Researcher

SECTION C: CERTIFICATION (FOR THIS COMPLETE SUBMITTAL)		
I am fully authorized to prepare and submit this information, as a formal response to the request pursuant to Health and Safety Code section 57019(d)(1), and certify the information and statements made herein, and in the attachments, are correct to the best of my knowledge and belief.		
Name: (type or print) Sang-Tae Kim	Signature: 	Date: December 15, 2011

SECTION D: NANOMATERIAL CHEMICAL AND PHYSICAL PROPERTIES (Attach additional pages as needed)		
PRODUCT / PRODUCTION INFORMATION		
NANO CHEMICAL NAME: Qdot® antibody conjugate		
<p>COMMERCIAL NAME(S): CD2, mouse anti-human, Qdot® 605 conjugate; CD3, hamster anti-mouse, (Qdot® 605 conjugate); CD3, mouse anti-human, Qdot® 605 conjugate (clone UCHT1); CD3, mouse anti-human, Qdot® 655 conjugate (clone S4.1); CD4, mouse anti-human, Qdot® 605 conjugate (clone S3.5); CD4, mouse anti-human, Qdot® 655 conjugate (clone S3.5); CD4, mouse anti-human, Qdot® 705 conjugate (clone S3.5); CD4, rat anti-mouse, (Qdot® 605 conjugate); CD8, mouse anti-human, Qdot® 565 conjugate; CD8, mouse anti-human, Qdot® 605 conjugate (clone 3B5); CD8, mouse anti-human, Qdot® 655 conjugate (clone 3B5); CD8, mouse anti-human, Qdot® 705 conjugate (clone 3B5); CD10, mouse anti-human, Qdot® 605 conjugate; CD10, mouse anti-human, Qdot® 800 conjugate; CD14, mouse anti-human, Qdot® 605 conjugate (clone TuK4); CD14, mouse anti-human, Qdot® 655 conjugate (clone HIT2); CD14, mouse anti-human, Qdot® 655 conjugate (clone Tuk4); CD14, mouse anti-human, Qdot® 800 conjugate (clone Tuk4); CD19, mouse anti-human, Qdot® 605 conjugate; CD19, mouse anti-human, Qdot® 655 conjugate; CD20, mouse anti-human, Qdot® 655 conjugate; CD27, mouse anti-human, Qdot® 605 conjugate (clone CLB-27/1); CD27, mouse anti-human, Qdot® 655 conjugate (clone CLB-27/1); CD38, mouse anti-human, Qdot® 605 conjugate (clone HIT2); CD45, mouse anti-human, Qdot® 605 conjugate (clone HI30); CD45, mouse anti-human, Qdot® 705 conjugate (clone HI30); CD45, mouse anti-human, Qdot® 800 conjugate; CD45R(B220), Rat anti-mouse, Qdot® 655 conjugate; CD45RA, mouse anti-human, Qdot® 605 conjugate (clone MEM-56); CD45RA, mouse anti-human, Qdot® 655 conjugate (clone MEM-56); CD56, mouse anti-human, Qdot® 605 conjugate; HLA-DR, Mouse anti-human, Qdot® 605 conjugate; HLA-DR, Mouse anti-human, Qdot® 800 conjugate; Mouse IgG1 Isotype Control, Qdot® 800 conjugate; Mouse IgG1, Qdot® 605 conjugate; Mouse IGG2A, QDOT 605 conjugate; Mouse IGG2A, QDOT 655 conjugate; Mouse IgG2a, Qdot® 705 conjugate; Mouse IgG2a, Qdot® 800 conjugate; Mouse IgG2b, Qdot® 605 conjugate; Qdot 565 goat anti-fluorescein conjugate; Qdot 655 goat anti-fluorescein conjugate; Qdot 655 rat anti-dinitrophenol conjugate; Qdot 655 wheat germ agglutinin conjugate; Qdot® 525 goat F(ab')₂ anti-mouse IgG conjugate (H+L) *1 µM solution*, 200 µL; Qdot® 565 goat F(ab')₂ anti-mouse IgG conjugate (H+L) *1 µM solution*, 200 µL; Qdot® 585 goat F(ab')₂ anti-mouse IgG conjugate (H+L) *1 µM solution*, 200 µL; Qdot® 605 goat F(ab')₂ anti-mouse IgG conjugate (H+L) *1 µM solution*, 200 µL; Qdot® 655 goat F(ab')₂ anti-mouse IgG conjugate (H+L) *1 µM solution*, 200 µL; Qdot® 705 goat F(ab')₂ anti-mouse IgG conjugate (H+L) *1 µM solution*, 200 µL; Qdot® 800 goat F(ab')₂ anti-mouse IgG conjugate (H+L) *1 µM solution*, 200 µL; Qdot® 565 goat F(ab')₂ anti-mouse IgG conjugate (H+L) *1 µM solution*, 100 µL; Qdot® 605 goat F(ab')₂ anti-mouse IgG conjugate (H+L) *1 µM solution*, 100 µL; Qdot® 625 goat F(ab')₂ anti-mouse IgG conjugate (H+L) *1 µM solution*, 100 µL; Qdot® 655 goat F(ab')₂ anti-mouse IgG conjugate (H+L) *1 µM solution*, 100 µL; Qdot® 705 goat F(ab')₂ anti-mouse IgG conjugate (H+L) *1 µM solution*, 100 µL; Qdot® 525 goat F(ab')₂ anti-rabbit IgG conjugate (H+L) *1 µM solution*, 200 µL; Qdot® 565 goat F(ab')₂ anti-rabbit IgG conjugate (H+L) *1 µM solution*, 200 µL; Qdot® 585 goat F(ab')₂ anti-rabbit IgG conjugate (H+L) *1 µM solution*, 200 µL; Qdot® 605 goat F(ab')₂ anti-rabbit IgG conjugate (H+L) *1 µM solution*, 200 µL; Qdot® 655 goat F(ab')₂ anti-rabbit IgG conjugate (H+L) *1 µM solution*, 200 µL; Qdot® 705 goat F(ab')₂ anti-rabbit IgG conjugate (H+L) *1 µM solution*, 200 µL; Qdot® 800 goat F(ab')₂ anti-rabbit IgG conjugate (H+L) *1 µM solution*, 200 µL; Qdot® 565 goat F(ab')₂ anti-rabbit IgG conjugate (H+L) *1 µM solution*, 100 µL; Qdot® 605 goat F(ab')₂ anti-rabbit IgG conjugate (H+L) *1 µM solution*, 100 µL; Qdot® 625 goat F(ab')₂ anti-rabbit IgG conjugate (H+L) *1 µM solution*, 100 µL; Qdot® 655 goat F(ab')₂ anti-rabbit IgG conjugate (H+L) *1 µM solution*, 100 µL; Qdot® 705 goat F(ab')₂ anti-rabbit IgG conjugate (H+L) *1 µM solution*, 100 µL; Qdot® 565 goat F(ab')₂ anti-rat IgG conjugate (H+L) *1 µM solution*; Qdot® 605 goat F(ab')₂ anti-rat IgG conjugate (H+L) *1 µM solution*; Qdot® 655 goat F(ab')₂ anti-rat IgG conjugate (H+L) *1 µM solution*; Qdot® 605 goat F(ab')₂ anti-human IgG conjugate (H+L) *1 µM solution*; Qdot® 655 goat F(ab')₂ anti-human IgG conjugate (H+L) *1 µM solution*; Qdot® 655 rabbit F(ab')₂ anti-goat IgG conjugate (H+L) *1 µM solution*; Qdot 565 goat anti-fluorescein conjugate *2 µM solution* *whole IgG* *Custom*; Qdot 605 goat anti-dansyl *2 µM solution* *whole IgG* *Custom*; Qdot 655 goat anti-DNP *2 µM solution* *whole IgG* *Custom*</p>		
ANNUAL PRODUCTION VOLUME: Total annual production is 3,470 grams. Quantity shipped to California is 0.257 gram.		
PRODUCTION METHOD(S): Core and core-shell nanoparticles are produced using common colloidal synthesis techniques. Some examples may be found in the following patents: 6,322,901; 6,815,064; 7,147,712; 7,695,642. Some examples of methods for applying the amphiphilic coating to these particles to render them water soluble may be found in the following patent 6,649,138.		
IDENTIFICATION OF THE SUPPLIER(S): Life Technologies is the producer and supplier of these products.		
PARAMETER	VALUE / RANGE	NAME OF ANALYTICAL METHOD(S)
PHYSICAL PROPERTIES		
SHAPE (MORPHOLOGY)	The morphology of a nanoparticle is most commonly measured by transmission electron microscopy (TEM) since	

		<p>it is the only analytical technique with resolution sufficient to resolve the fine features of a nanoparticle. This technique is limited, however, since it is most sensitive to electron dense elements of the nanoparticle like cadmium, zinc and selenium and virtually insensitive to lighter elements like carbon, hydrogen, oxygen and nitrogen. This means that shape and morphology information is not available for nanoparticles that comprise organic coatings. In other words, TEM can only give you information about the nanocrystal within a nanoparticle. TEM is further limited by the fact that the data acquired is only a two dimensional projection of the three dimensional shape. Therefore to calculate the volume or surface area, a three dimensional shape must be assumed. The size of the nanoparticle (nanocrystal and organic ligands) can be measured by size exclusion chromatography (SEC) but this technique does not have the resolution to provide morphology information.</p>	
DENSITY		The density of these materials has not been measured	
SURFACE AREA		Since we cannot measure the morphology of Qdot® antibody conjugate nanoparticles, we cannot calculate the surface area. If we approximate the morphology as a sphere and use the SEC sizing data, we can calculate a spherical surface area.	
PARTICLE SIZE DISTRIBUTION	Air	To the best of our knowledge, no technique is currently available	
	Liquid	Dynamic light scattering can give particle size distribution data, however, several complications exist in interpreting the data. Some of those caveats include, (1) since quantum dots have broad absorbance, any color that emits at longer wavelengths than the laser will absorb some of the laser light and make interpretation of the data nearly impossible, (2) large particles scatter much more efficiently than smaller particles making detection of small particle populations difficult.	
	Solid/ Powder	To the best of our knowledge, no technique is currently available	
OTHER (SPECIFY)			
CHEMICAL PROPERTIES			
CHEMICAL COMPOSITION		<p>The inorganic portion of the nanoparticles (nanocrystal) is composed of cadmium, selenium, zinc and sulfur. Two of our nanocrystal products (Qdot 705 and 800) additionally contain tellurium. The exact composition of the ligand shell is unknown but NMR has revealed that it is mostly composed of tetradecylphosphonic acid (TDPA) and/or other phosphorus-containing species. The polymer coating is an amphiphilic molecule that is associated with the nanoparticle and provides water solubility. The polyethylene glycol (PEG) coating is attached to the polymer coating through amide bonds created by reacting amine-functional PEG molecules with carbodiimide (e.g., 1-Ethyl-3-[3-dimethylaminopropyl]carbodiimide hydrochloride) activated carboxylate groups on the polymer coating. The particle surface is then made sulfur reactive by reacting a heterobifunctional crosslinker (e.g., Sulfosuccinimidyl-4-(N-maleimidomethyl)cyclohexane-1-carboxylate) to residual amine functional groups on the terminal ends of the PEG molecules. The crosslinker is attached to the quantum dot through an amide bond. Lastly, the sulfur reactive quantum dots are incubated with antibodies that have either been reduced, with for example</p>	<p>The chemical composition of this polymer is best described in Patent Number 6,649,138</p>

		dithiothreitol, or thiolated with a common thiolation reagent like 2-iminothiolane. Thioether are formed between the quantum dot and the antibody.	
SURFACE MODIFICATION (COATING, FUNCTIONALIZATION)		The outer surface contains an amphiphilic polymer, PEG and antibodies	The process of applying this polymer to the nanoparticles is best described in patent number 6,649,138.
PURITY		Purity is essential for our products. We have most routinely use SEC to detect and measure impurities. Some of those impurities include aggregated nanoparticles, free (unbound) amphiphilic polymer, and other nanoparticle impurities.	
SURFACE CHARGE		We routinely perform gel electrophoresis to confirm the charge of a particle but we do not quantitate it in terms of charge density.	
DISPERSION	Air	We do not handle air dispersions in our operations or R&D	
	Liquid	Presence of aggregated particles is routinely measured by SEC chromatography. In fact, all of our products and water soluble intermediates have specifications around the percentage of these soluble aggregates present in the solution.	
	Solid	We do not handle the materials in the solid form, but as a liquid dispersion.	
IDENTIFYING AND DETERMINING CONCENTRATION OF NANO CHEMICAL, ITS METABOLITES, AND DEGRADATION PRODUCTS IN SPECIFIED MATRICES (Water, Air, Soil, Sediment, Sludge, Chemical Waste, Fish, Blood, Adipose Tissue, Urine, Other)		Determining the exact concentration of nanoparticles in any matrix is difficult because routine nanoparticle counting techniques do not currently exist. The most common method for determining the concentration of quantum dots is to measure the optical absorbance in solution at a concentration where Beer's law is operative and calculate the concentration using an estimated extinction coefficient for the material.	A example of a common technique for estimating the extinction coefficient for quantum dot can be found in this reference (Chem. Mater. 2003, 15, 2854-2860)
SOLUBILITY	Water Solubility	Soluble/miscible in water. These products are sold at a concentration of 1 micromolar which is in the range of 0.06 mg/mL to 1 mg/mL depending on the color.	
	Solubility in Organic Solvent	Not soluble/miscible in organic solvent	
N-OCTANOL-WATER PARTITION COEFFICIENT		We have not measured this parameter.	
STABILITY AND REACTIVITY	Flammability	These nanoparticle products are sold as dilute (1 μ M or approximately 0.06 mg to 1 mg/mL) aqueous solutions and are therefore classified with a HMIS flammability rating of 0 (same as water).	
	Explosiveness	These products do not pose an explosion hazard. This conclusion is partially based on thermogravimetric analysis (TGA) of our ITK organic quantum dots. TGA shows that no weight loss occurs until about 300 °C. At around 300 °C the particles lose about 10 - 20 % of their mass. This temperature coincides with the boiling point of the organic ligands used in the synthesis of quantum dots. No other weight loss is observed up to a temperature of 650 °C.	
	Oxidizing Properties	These products are not strong oxidizing agents.	
	Oxidation Reduction Potential	These products are not strong reducing agents.	

Qdot® antibody conjugate

	Storage Stability and Reactivity (Container Material)	These products are stable in a variety of container materials including, glass and plastic. The product is packaged and shipped in polypropylene vials.	
	Stability to Thermal, Sunlight, and Metal(s)	These products are stable, meaning that they will work for their intended purpose, to multiple rounds of freezing and thawing and moderately high temperatures (0 °C to 37 °C). These products are stable and will work for their intended purpose with moderate sunlight exposure. Some metals will quench the florescence from these particles. Particularly copper (II) and iron (III).	Reference - Cytometry Part A, 79A: 84 89, 2011

Qdot® antibody conjugate

SECTION E: Provide a copy of your Globally Harmonized System (GHS) Safety Data Sheet (SDS), if you have prepared one.

Attached is current SDS/Material Safety Data Sheet (MSDS). See Attachment 1

SECTION F: For each nanomaterial you produce or import, describe the analytical test method(s) that you use, or plan to use, to sample, prepare, and analyze a specific matrix to determine the identity and concentration of each specified nanomaterial. Use a separate page to describe the procedure for each, individual matrix, which must include water, air, soil, sediment, sludge, chemical waste, fish, blood, adipose tissue, and urine. Include the information requested in Section D above.

Life Technologies' *Medical Surveillance and Monitoring Plan* requires a bi-annual monitoring of blood and urine samples as well as an annual physical examination of employees who are involved in manufacturing of quantum dots. No cadmium was detectable from either blood or urine samples, when analyzed with the use of Inductively Coupled Plasma/Mass Spectrometry (ICP-MS) (see <http://www.aruplab.com/guides/ug/tests/0025040.jsp> for detailed information on sampling and analysis methodology).

We have not determined the identity and concentration of Qdot® antibody conjugate in environmental matrix including air, soil, sediment, sludge, chemical waste, fish, and adipose tissue.

ATTACHMENT 1
MATERIAL SAFETY DATA SHEET
(Sample)



SAFETY DATA SHEET

1. Identification of the substance/mixture and of the company/undertaking

Identification of the substance/preparation

Product code Q10172
Product name CD2, mouse anti-human, Qdot® 605 conjugate (clone S5.5) *1 uM solution*

Company/Undertaking Identification

Life Technologies
5791 VAN ALLEN WAY
PO BOX 6482
CARLSBAD, CA 92008
+1 760 603 7200

INVITROGEN CORPORATION
5250 MAINWAY DRIVE
BURLINGTON, ONT
CANADA L7L 6A4
800/263-6236

24 hour Emergency Response (Transport): 866-536-0631
301-431-8585
Outside of the U.S. +1-301-431-8585

For research use only. Not intended for human or animal diagnostic or therapeutic uses.

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Product name CD2, mouse anti-human, Qdot® 605 conjugate (clone S5.5) *1 uM solution*

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2. Hazards identification

GHS - Classification

Signal Word
not hazardous

Health Hazard
not hazardous

Physical Hazards
not hazardous

**Principle Routes of Exposure/
Potential Health effects**

Eyes	May cause eye irritation with susceptible persons.
Skin	May cause skin irritation in susceptible persons.
Inhalation	May be harmful by inhalation.
Ingestion	May be harmful if swallowed.

Specific effects

Carcinogenic effects	none.
Mutagenic effects	none.
Reproductive toxicity	none.
Sensitization	none

Target Organ Effects No known effects under normal use conditions

HMIS

Health	0
Flammability	0
Reactivity	0

3. Composition/information on ingredients

Chemical Name	CAS-No	EINECS-No	Weight %
Sodium azide	28628-22-8	247-852-1	<0.1

The product contains no substances which at their given concentration, are considered to be hazardous to health. We recommend handling all chemicals with caution.

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S5.5) *1 uM solution*

4. First aid measures

Skin contact	Rinse with plenty of water. If symptoms arise, call a physician.
Eye contact	Rinse immediately with plenty of water, also under the eyelids, for at least 15 minutes. If symptoms persist, call a physician.
Ingestion	Never give anything by mouth to an unconscious person. If symptoms persist, call a physician. Do not induce vomiting without medical advice.
Inhalation	Move to fresh air. If symptoms persist, call a physician. If not breathing, give artificial respiration.
Notes to physician	Treat symptomatically.

5. Fire-fighting measures

Suitable extinguishing media	Water spray. Carbon dioxide (CO ₂). Foam. Dry chemical.
Special protective equipment for firefighters	Wear self-contained breathing apparatus and protective suit.

6. Accidental release measures

Personal precautions	Use personal protective equipment.
Methods for cleaning up	Soak up with inert absorbent material.

Environmental precautions

Prevent further leakage or spillage if safe to do so.

See Section 12 for additional information.

7. Handling and storage

Handling	Always wear recommended Personal Protective Equipment. No special handling advice required.
Storage	Keep in a dry, cool and well-ventilated place.

8. Exposure controls/personal protection

Exposure limits

At this time, the limited evidence available suggests caution when potential exposures to nanoparticles may occur. Due to the limited information about health risks from nanomaterials, it is prudent to take steps for minimizing worker exposures. Research is still needed to understand the impact of nanotechnology on health, and to determine appropriate exposure monitoring and control strategies.

<u>Engineering measures</u>	Ensure adequate ventilation, especially in confined areas.
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Personal protective equipment

Respiratory protection	In case of insufficient ventilation wear suitable respiratory equipment.
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Hand protection	Impervious gloves.
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Eye protection
Skin and body protection.
Hygiene measures

Safety glasses with side-shields.
 Lightweight protective clothing.
 Handle in accordance with good industrial hygiene and safety practice.

Environmental exposure controls

Prevent product from entering drains.

9. Physical and chemical properties

General Information

Form	suspension	
Appearance	liquid	
Odor	No information available	
Boiling Point/Range	°C no data available	°F no data available
Melting point/range	°C no data available	°F no data available
Flash point	°C no data available	°F no data available
Autoignition temperature	°C no data available	°F no data available
Oxidizing properties	No information available.	
Water solubility	soluble	
pH VALUE	8.3	

10. Stability and reactivity

Stability	Stable under normal conditions.
Materials to avoid	No dangerous reaction known under conditions of normal use.
Hazardous decomposition products	None under normal use
polymerization	Hazardous polymerisation does not occur.

11. Toxicological information

Acute toxicity

At this time, the limited evidence available suggests caution when potential exposures to nanoparticles may occur. Due to the limited information about health risks from nanomaterials, it is prudent to take steps for minimizing worker exposures. Occupational health risks associated with manufacturing and using nanomaterials are not yet clearly understood. Studies have indicated that low solubility nanoparticles are more toxic than larger particles on a mass for mass basis. There are strong indications that particle surface area and surface chemistry are responsible for observed responses in cell cultures and animals. There are indications that nanoparticles can penetrate through the skin or move from the respiratory system to other organs.

Chemical Name	LD50 (oral, rat/mouse)	LD50 (dermal, rat/rabbit)	LC50 (inhalation, rat/mouse)
Sodium azide	= 27 mg/kg (Rat)	no data available	no data available

**Principle Routes of Exposure/
 Potential Health effects**

Eyes	May cause eye irritation with susceptible persons.
Skin	May cause skin irritation in susceptible persons.
Inhalation	May be harmful by inhalation.
Ingestion	May be harmful if swallowed.

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Carcinogenic effects	none
Mutagenic effects	none
Reproductive toxicity	none
Sensitization	none
Target Organ Effects	No known effects under normal use conditions

12. Ecological information

Ecotoxicity effects	No information available.
Mobility	No information available.
Biodegradation	Inherently biodegradable
Bioaccumulation	Does not bioaccumulate.

13. Disposal considerations

Dispose of in accordance with local regulations.

14. Transport information

IATA

Proper shipping name	Not classified as dangerous in the meaning of transport regulations
Hazard class	none
Subsidiary Class	none
Packing group	none
UN-No	None

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Product name CD2, mouse anti-human, Qdot® 605 conjugate (clone S5.5) *1 uM solution*

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15. Regulatory information

Component	TSCA
Sodium azide 28628-22-8 (<0.1)	Listed

U.S. Federal Regulations

SARA 313

This product contains the following toxic chemical(s) subject to the notification requirements of section 313 of Title III of the Superfund Amendments and Reauthorization Act of 1980. This law requires certain manufacturers to report on annual emissions of specified chemicals and chemical categories. Please note that if you repackage, or otherwise redistribute, this product to industrial customers, a notice similar to this one should be sent to those customers:

Chemical Name	CAS-No	Weight %	SARA 313 - Threshold Values
Sodium azide	28628-22-8	<0.1	1.0

Clean Air Act, Section 112 Hazardous Air Pollutants (HAPs) (see 40 CFR 61)

This product does not contains HAPs.

U.S. State Regulations

Chemical Name	Massachusetts - RTK	New Jersey - RTK	Pennsylvania - RTK	Illinois - RTK	Rhode Island - RTK
Sodium azide	Listed	Listed	Listed	-	Listed

California Proposition 65

This product does not contain chemicals listed under Proposition 65

WHMIS hazard class:

Non-controlled

This product has been classified according to the hazard criteria of the CFR and the MSDS contains all of the information required by the CFR

16. Other information

Reason for Revision (M)SDS sections updated.

For research use only. Not intended for human or animal diagnostic or therapeutic uses.

References

- * National Institute for Occupational Safety and Health (NIOSH), U.S., 2010:
<http://www.cdc.gov/niosh/topics/nanotech/>
- * National Institute for Occupational Safety and Health (NIOSH), U.S., 2009:
<http://www.cdc.gov/niosh/docs/2009-125/pdfs/2009-125.pdf>

The above information was acquired by diligent search and/or investigation and the recommendations are based on prudent application of professional judgment. The information shall not be taken as being all inclusive and is to be used only as a guide. All materials and mixtures may present unknown hazards and should be used with caution. Since the Company cannot control the actual methods, volumes, or conditions of use, the Company shall not be held liable for any damages or losses resulting from the handling or from contact with the product as described herein. **THE INFORMATION IN THIS MSDS DOES NOT CONSTITUTE A WARRENTY, EXPRESSED OR IMPLIED, INCLUDING ANY IMPLIED WARRANTY OF MERCHANTABILITY OR FITNESS FOR ANY PARTICULAR PUPOSE.**

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End of Safety Data Sheet

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STATE OF CALIFORNIA
Department of Toxic Substances Control

Health and Safety Code Section 57019 Chemical Information Call-in Information
For Nanometals, Nanometal Oxides, and Quantum Dots
December 2010

This enclosure is provided for your convenience. You may provide the requested information in writing, and attaching any supplementary materials or explanatory information, in letter or report form.

SECTION A: CHEMICAL(S) (Check each one which applies for your company)		
<input type="checkbox"/> Nano Silver	<input type="checkbox"/> Nano Titanium Dioxide	<input type="checkbox"/> Nano Cerium Oxide
<input type="checkbox"/> Nano Zero Valent Iron	<input type="checkbox"/> Nano Zinc Oxide	<input checked="" type="checkbox"/> Quantum Dot(s)

SECTION B: BUSINESS IDENTIFICATION INFORMATION (check one and complete 1 – 10)				
<input type="checkbox"/> Sole Owner	<input checked="" type="checkbox"/> Corporation	<input type="checkbox"/> Limited Liability Company (LLC)	<input type="checkbox"/> Limited Liability Partnership (LLP)	<input type="checkbox"/> Unincorporated Business Trust
<input type="checkbox"/> Spouses' Co-ownership	<input type="checkbox"/> Registered Domestic Partnership	<input type="checkbox"/> General Partnership	<input type="checkbox"/> Limited Partnership	<input type="checkbox"/> Other: (describe)
1. Name of Sole Owner, Corporation, Partnership, Institute, Other. Life Technologies Corporation				
2. Business Trade Name ("Doing Business As," if any) None				
3. Business Address (physical location of your business: street number and name, city, state, country, zip or postal code) 5791 Van Allen Way, Carlsbad, California 92008, USA				
4. Mailing Address (street name and number, P.O. box, city, state, country, zip or postal code, if different from 3) The Same as Above				
5. Business Website Address(es): http://www.lifetechnologies.com				
6. Name of Owner, Responsible Corporate Officer, Partner, Other. Sang-Tae Kim				
7. Contact Information for Person in 6 above.				
Name: Sang-Tae Kim		Title: Manager, Design-for-Environment/EHS		
Business Telephone: 650-554-2798		Email: sang-tae.kim@lifetech.com		
8. Number of Employees (California employees). 2908				
9. NAICS Code(s) for this business:		Primary: 325413	Other:	Other:
10. Nano Chemical Business Type: (check applicable)		<input checked="" type="checkbox"/> Manufacturer	<input checked="" type="checkbox"/> Importer	<input checked="" type="checkbox"/> Researcher

SECTION C: CERTIFICATION (FOR THIS COMPLETE SUBMITTAL)		
I am fully authorized to prepare and submit this information, as a formal response to the request pursuant to Health and Safety Code section 57019(d)(1), and certify the information and statements made herein, and in the attachments, are correct to the best of my knowledge and belief.		
Name: (type or print) Sang-Tae Kim	Signature: 	Date: December 15, 2011

SECTION D: NANOMATERIAL CHEMICAL AND PHYSICAL PROPERTIES (Attach additional pages as needed)		
PRODUCT / PRODUCTION INFORMATION		
NANO CHEMICAL NAME: Qdot® streptavidin conjugate		
COMMERCIAL NAME(S): Qdot® 525 streptavidin conjugate *1 µM solutions*; Qdot® 565 streptavidin conjugate *1 µM solutions*; Qdot® 585 streptavidin conjugate *1 µM solutions*; Qdot® streptavidin conjugate *1 µM solutions*; Qdot® 655 streptavidin conjugate *1 µM solutions*; Qdot® 705 streptavidin conjugate *1 µM solutions*; Qdot® 800 streptavidin conjugate *1 µM solutions*; Qdot® Streptavidin Sampler Kit *1 µM solutions*; Qdot® 705 streptavidin *2 µM solution* *Custom*		
ANNUAL PRODUCTION VOLUME: Total annual production is 1.416 grams. Quantity shipped to California is 0.1261 gram.		
PRODUCTION METHOD(S): Core and core-shell nanoparticles are produced using common colloidal synthesis techniques. Some examples may be found in the following patents: 6,322,901; 6,815,064; 7,147,712; 7,695,642. Some examples of methods for applying the amphiphilic coating to these particles to render them water soluble may be found in the following patent 6,649,138.		
IDENTIFICATION OF THE SUPPLIER(S): Life Technologies is the producer and supplier of these products.		
PARAMETER	VALUE / RANGE	NAME OF ANALYTICAL METHOD(S)
PHYSICAL PROPERTIES		
SHAPE (MORPHOLOGY)	The morphology of a nanoparticle is most commonly measured by transmission electron microscopy (TEM) since it is the only analytical technique with resolution sufficient to resolve the fine features of a nanoparticle. This technique is limited, however, since it is most sensitive to electron dense elements of the nanoparticle like cadmium, zinc and selenium and virtually insensitive to lighter elements like carbon, hydrogen, oxygen and nitrogen. This means that shape and morphology information is not available for nanoparticles that comprise organic coatings. In other words, TEM can only give you information about the nanocrystal within a nanoparticle. TEM is further limited by the fact that the data acquired is only a two dimensional projection of the three dimensional shape. Therefore to calculate the volume or surface area, a three dimensional shape must be assumed. The size of the nanoparticle (nanocrystal and organic ligands) can be measured by size exclusion chromatography (SEC) but this technique does not have the resolution to provide morphology information.	
DENSITY	The density of these materials has not been measured	
SURFACE AREA	Since we cannot measure the morphology of Qdot® streptavidin conjugate nanoparticles, we cannot calculate the surface area. If we approximate the morphology as a sphere and use the SEC sizing data, we can calculate a spherical surface area.	
PARTICLE SIZE DISTRIBUTION	Air	To the best of our knowledge, no technique is currently available
	Liquid	Dynamic light scattering can give particle size distribution data, however, several complications exist in interpreting the data. Some of those caveats include, (1) since quantum dots have broad absorbance, any color that emits at longer wavelengths than the laser will absorb some of the laser light and make interpretation of the data nearly impossible, (2) large particles scatter much more efficiently than smaller particles making detection of small particle populations difficult.
	Solid/ Powder	To the best of our knowledge, no technique is currently available
OTHER (SPECIFY)		
CHEMICAL PROPERTIES		

CHEMICAL COMPOSITION		The inorganic portion of the nanoparticles (nanocrystal) is composed of cadmium, selenium, zinc and sulfur. Two of our nanocrystal products (Qdot 705 and 800) additionally contain tellurium. The exact composition of the ligand shell is unknown but NMR has revealed that it is mostly composed of tetradecylphosphonic acid (TDPA) and/or other phosphorus-containing species. The polymer coating is an amphiphilic molecule that is associated with the nanoparticle and provides water solubility. The polyethylene glycol (PEG) coating is attached to the polymer coating through amide bonds created by reacting amine-functional PEG molecules with carbodiimide (e.g., 1-Ethyl-3-[3-dimethylaminopropyl]carbodiimide hydrochloride) activated carboxylate groups on the polymer coating. The particle surface is then made amine reactive by reacting a homobifunctional crosslinker (e.g., Bis[sulfosuccinimidyl] suberate) to residual amine functional groups on the terminal ends of the PEG molecules. The crosslinker is attached to the quantum dot through an amide bond. Lastly, the amine reactive quantum dots are incubated with streptavidin. Amide bonds are formed between the quantum dot and streptavidin.	The chemical composition of this polymer is best described in Patent Number 6,649,138
SURFACE MODIFICATION (COATING, FUNCTIONALIZATION)		The outer surface contains an amphiphilic polymer, polyethylene glycol and streptavidin.	The process of applying this polymer to the nanoparticles is best described in patent number 6,649,138.
PURITY		Purity is essential for our products. We have most routinely use SEC to detect and measure impurities. Some of those impurities include aggregated nanoparticles, free (unbound) amphiphilic polymer, and other nanoparticle impurities.	
SURFACE CHARGE		We routinely perform gel electrophoresis to confirm the charge of a particle but we do not quantitate it in terms of charge density.	
DISPERSION	Air	We do not handle air dispersions in our operations or R&D	
	Liquid	Presence of aggregated particles is routinely measured by SEC chromatography. In fact, all of our products and water soluble intermediates have specifications around the percentage of these soluble aggregates present in the solution.	
	Solid	We do not handle the materials in the solid form, but as a liquid dispersion.	
IDENTIFYING AND DETERMINING CONCENTRATION OF NANO CHEMICAL, ITS METABOLITES, AND DEGRADATION PRODUCTS IN SPECIFIED MATRICES (Water, Air, Soil, Sediment, Sludge, Chemical Waste, Fish, Blood, Adipose Tissue, Urine, Other)		Determining the exact concentration of nanoparticles in any matrix is difficult because routine nanoparticle counting techniques do not currently exist. The most common method for determining the concentration of quantum dots is to measure the optical absorbance in solution at a concentration where Beer's law is operative and calculate the concentration using an estimated extinction coefficient for the material.	A example of a common technique for estimating the extinction coefficient for quantum dot can be found in this reference (Chem. Mater. 2003, 15, 2854-2860)
SOLUBILITY	Water Solubility	Soluble/miscible in water. These products are sold at a concentration of 1 micromolar which is in the range of 0.06 mg/mL to 1 mg/mL depending on the color.	
	Solubility in Organic Solvent	Not soluble/miscible in organic solvent	

Qdot® streptavidin conjugate

N-OCTANOL-WATER PARTITION COEFFICIENT		We have not measured this parameter.	
STABILITY AND REACTIVITY	Flammability	These nanoparticle products are sold as dilute (1 µM or approximately 0.06 mg to 1 mg/mL) aqueous solutions and are therefore classified with a HMIS flammability rating of 0 (same as water).	
	Explosiveness	These products do not pose an explosion hazard. This conclusion is partially based on thermogravimetric analysis (TGA) of our ITK organic quantum dots. TGA shows that no weight loss occurs until about 300 °C. At around 300 °C the particles lose about 10 - 20 % of their mass. This temperature coincides with the boiling point of the organic ligands used in the synthesis of quantum dots. No other weight loss is observed up to a temperature of 650 °C.	
	Oxidizing Properties	These products are not strong oxidizing agents.	
	Oxidation Reduction Potential	These products are not strong reducing agents.	
	Storage Stability and Reactivity (Container Material)	These products are stable in a variety of container materials including, glass and plastic. The product is packaged and shipped in polypropylene vials.	
	Stability to Thermal, Sunlight, and Metal(s)	These products are stable, meaning that they will work for their intended purpose, to multiple rounds of freezing and thawing and moderately high temperatures (0 °C to 37 °C). These products are stable and will work for their intended purpose with moderate sunlight exposure. Some metals will quench the florescence from these particles. Particularly copper (II) and iron (III).	Reference - Cytometry Part A, 79A: 84 89, 2011

SECTION E: Provide a copy of your Globally Harmonized System (GHS) Safety Data Sheet (SDS), if you have prepared one.

Attached is current SDS/Material Safety Data Sheet (MSDS). See Attachment 1

SECTION F: For each nanomaterial you produce or import, describe the analytical test method(s) that you use, or plan to use, to sample, prepare, and analyze a specific matrix to determine the identity and concentration of each specified nanomaterial. Use a separate page to describe the procedure for each, individual matrix, which must include water, air, soil, sediment, sludge, chemical waste, fish, blood, adipose tissue, and urine. Include the information requested in Section D above.

Life Technologies' *Medical Surveillance and Monitoring Plan* requires a bi-annual monitoring of blood and urine samples as well as an annual physical examination of employees who are involved in manufacturing of quantum dots. No cadmium was detectable from either blood or urine samples, when analyzed with the use of Inductively Coupled Plasma/Mass Spectrometry (ICP-MS) (see <http://www.aruplab.com/guides/ug/tests/0025040.jsp> for detailed information on sampling and analysis methodology).

We have not determined the identity and concentration of Qdot® streptavidin conjugate in environmental matrix including air, soil, sediment, sludge, chemical waste, fish, and adipose tissue.

ATTACHMENT 1
MATERIAL SAFETY DATA SHEET
(Sample)



SAFETY DATA SHEET

1. Identification of the substance/mixture and of the company/undertaking

Identification of the substance/preparation

Product code Q10141MP
Product name Qdot® 525 streptavidin conjugate

Company/Undertaking Identification

Life Technologies
5791 VAN ALLEN WAY
PO BOX 6482
CARLSBAD, CA 92008
+1 760 603 7200

INVITROGEN CORPORATION
5250 MAINWAY DRIVE
BURLINGTON, ONT
CANADA L7L 6A4
800/263-6236

24 hour Emergency Response (Transport): 866-536-0631
301-431-8585
Outside of the U.S. +1-301-431-8585

For research use only. Not intended for human or animal diagnostic or therapeutic uses.

Revision Date 15-Dec-2011
Product code Q10141MP

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Product name Qdot® 525 streptavidin conjugate

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2. Hazards identification

GHS - Classification

Signal Word
not hazardous

Health Hazard
not hazardous

Physical Hazards
not hazardous

**Principle Routes of Exposure/
Potential Health effects**

Eyes	May cause eye irritation with susceptible persons.
Skin	May cause skin irritation in susceptible persons.
Inhalation	May be harmful by inhalation.
Ingestion	May be harmful if swallowed.

Specific effects

Carcinogenic effects	none
Mutagenic effects	none
Reproductive toxicity	none
Sensitization	none

Target Organ Effects No known effects under normal use conditions.

HMS

Health	0
Flammability	0
Reactivity	0

3. Composition/information on ingredients

Chemical Name	CAS-No	EINECS-No	Weight %
Sodium azide	26628-22-8	247-852-1	<0.1

The product contains no substances which at their given concentration, are considered to be hazardous to health. Sodium azide may react with lead and copper plumbing to form highly explosive metal azides. We recommend handling all chemicals with caution.

Revision Date 15-Dec-2011
Product code Q10141MP

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Product name Qdot® 525 streptavidin conjugate

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4. First aid measures

Skin contact	Rinse with plenty of water. If symptoms arise, call a physician.
Eye contact	Rinse immediately with plenty of water, also under the eyelids, for at least 15 minutes. If symptoms persist, call a physician.
Ingestion	Never give anything by mouth to an unconscious person. If symptoms persist, call a physician. Do not induce vomiting without medical advice.
Inhalation	Move to fresh air. If symptoms persist, call a physician. If not breathing, give artificial respiration.
Notes to physician	Treat symptomatically.

5. Fire-fighting measures

Suitable extinguishing media	Water spray. Carbon dioxide (CO2). Foam. Dry chemical.
Special protective equipment for firefighters	Wear self-contained breathing apparatus and protective suit.

6. Accidental release measures

Personal precautions	Use personal protective equipment.
Methods for cleaning up	Soak up with inert absorbent material.

Environmental precautions

Prevent further leakage or spillage if safe to do so.

See Section 12 for additional information.

7. Handling and storage

Handling	Always wear recommended Personal Protective Equipment. No special handling advice required.
Storage	Keep in a dry, cool and well-ventilated place.

8. Exposure controls/personal protection

Exposure limits

At this time, the limited evidence available suggests caution when potential exposures to nanoparticles may occur. Due to the limited information about health risks from nanomaterials, it is prudent to take steps for minimizing worker exposures. Research is still needed to understand the impact of nanotechnology on health, and to determine appropriate exposure monitoring and control strategies.

<u>Engineering measures</u>	Ensure adequate ventilation, especially in confined areas.
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Personal protective equipment

Respiratory protection	In case of insufficient ventilation wear suitable respiratory equipment.
-------------------------------	--

Hand protection	Impervious gloves.
Eye protection	Safety glasses with side-shields.
Skin and body protection.	Lightweight protective clothing.
Hygiene measures	Handle in accordance with good industrial hygiene and safety practice.

Revision Date 15-Dec-2011
Product code Q10141MP

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Product name Qdot® 525 streptavidin conjugate

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Environmental exposure controls

Prevent product from entering drains.

9. Physical and chemical properties**General information**

Form	suspension	
Appearance	liquid	
Odor	No information available	
Boiling Point/Range	°C no data available	°F no data available
Melting point/range	°C no data available	°F no data available
Flash point	°C no data available	°F no data available
Autoignition temperature	°C no data available	°F no data available
Oxidizing properties	No information available.	
Water solubility	soluble	

10. Stability and reactivity

Stability	Stable under normal conditions.
Materials to avoid	No dangerous reaction known under conditions of normal use. Sodium azide may react with lead and copper plumbing to form highly explosive metal azides.
Hazardous decomposition products	None under normal use
polymerization	Hazardous polymerisation does not occur.

11. Toxicological information**Acute toxicity**

At this time, the limited evidence available suggests caution when potential exposures to nanoparticles may occur. Due to the limited information about health risks from nanomaterials, it is prudent to take steps for minimizing worker exposures. Occupational health risks associated with manufacturing and using nanomaterials are not yet clearly understood. Studies have indicated that low solubility nanoparticles are more toxic than larger particles on a mass for mass basis. There are strong indications that particle surface area and surface chemistry are responsible for observed responses in cell cultures and animals. There are indications that nanoparticles can penetrate through the skin or move from the respiratory system to other organs.

Chemical Name	LD50 (oral, rat/mouse)	LD50 (dermal, rat/rabbit)	LC50 (inhalation, rat/mouse)
Sodium azide	= 27 mg/kg (Rat)	no data available	no data available

Principle Routes of Exposure/**Potential Health effects**

Eyes	May cause eye irritation with susceptible persons.
Skin	May cause skin irritation in susceptible persons.
Inhalation	May be harmful by inhalation.
Ingestion	May be harmful if swallowed.
Carcinogenic effects	none
Mutagenic effects	none
Reproductive toxicity	none
Sensitization	none

Revision Date 15-Dec-2011
Product code Q10141MP

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Product name Qdot® 525 streptavidin conjugate

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Target Organ Effects No known effects under normal use conditions.

12. Ecological information

Ecotoxicity effects	No information available.
Mobility	No information available.
Biodegradation	Inherently biodegradable
Bioaccumulation	Does not bioaccumulate.

13. Disposal considerations

Dispose of in accordance with local regulations.

14. Transport information

IATA

Proper shipping name	Not classified as dangerous in the meaning of transport regulations
Hazard class	none
Subsidiary Class	none
Packing group	none
UN-No	None

15. Regulatory information

Component	TSCA
Sodium azide 28628-22-8 (<0.1)	Listed

U.S. Federal Regulations

SARA 313

This product contains the following toxic chemical(s) subject to the notification requirements of section 313 of Title III of the Superfund Amendments and Reauthorization Act of 1980. This law requires certain manufacturers to report on annual emissions of specified chemicals and chemical categories. Please note that if you repackage, or otherwise redistribute, this product to industrial customers, a notice similar to this one should be sent to those customers:

Chemical Name	CAS-No	Weight %	SARA 313 - Threshold Values
Sodium azide	28628-22-8	<0.1	1.0

Clean Air Act, Section 112 Hazardous Air Pollutants (HAPs) (see 40 CFR 61)

This product does not contain HAPs.

U.S. State Regulations

Chemical Name	Massachusetts - RTK	New Jersey - RTK	Pennsylvania - RTK	Illinois - RTK	Rhode Island - RTK
Sodium azide	Listed	Listed	Listed	-	Listed

California Proposition 65

This product does not contain chemicals listed under Proposition 65

WHMIS hazard class:

Non-controlled

This product has been classified according to the hazard criteria of the CPR and the MSDS contains all of the information required by the CPR

16. Other information

Reason for Revision (M)SDS sections updated.

For research use only. Not intended for human or animal diagnostic or therapeutic uses.

References

- National Institute for Occupational Safety and Health (NIOSH), U.S., 2010:
<http://www.cdc.gov/niosh/topics/nanotech/>
- National Institute for Occupational Safety and Health (NIOSH), U.S., 2009:
<http://www.cdc.gov/niosh/docs/2009-125/pdfs/2009-125.pdf>

The above information was acquired by diligent search and/or investigation and the recommendations are based on prudent application of professional judgment. The information shall not be taken as being all inclusive and is to be used only as a guide. All materials and mixtures may present unknown hazards and should be used with caution. Since the Company cannot control the actual methods, volumes, or conditions of use, the Company shall not be held liable for any damages or losses resulting from the handling or from contact with the product as described herein. THE INFORMATION IN THIS MSDS DOES NOT CONSTITUTE A WARRANTY, EXPRESSED OR IMPLIED, INCLUDING ANY IMPLIED WARRANTY OF MERCHANTABILITY OR FITNESS FOR ANY PARTICULAR PURPOSE.

End of Safety Data Sheet

Revision Date 15-Dec-2011
Product code Q10141MP

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Product name Qdot® 525 streptavidin conjugate

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STATE OF CALIFORNIA
Department of Toxic Substances Control

Health and Safety Code Section 57019 Chemical Information Call-in Information
For Nanometals, Nanometal Oxides, and Quantum Dots
December 2010

This enclosure is provided for your convenience. You may provide the requested information in writing, and attaching any supplementary materials or explanatory information, in letter or report form.

SECTION A: CHEMICAL(S) (Check each one which applies for your company)		
<input type="checkbox"/> Nano Silver	<input type="checkbox"/> Nano Titanium Dioxide	<input type="checkbox"/> Nano Cerium Oxide
<input type="checkbox"/> Nano Zero Valent Iron	<input type="checkbox"/> Nano Zinc Oxide	<input checked="" type="checkbox"/> Quantum Dot(s)

SECTION B: BUSINESS IDENTIFICATION INFORMATION (check one and complete 1 – 10)				
<input type="checkbox"/> Sole Owner	<input checked="" type="checkbox"/> Corporation	<input type="checkbox"/> Limited Liability Company (LLC)	<input type="checkbox"/> Limited Liability Partnership (LLP)	<input type="checkbox"/> Unincorporated Business Trust
<input type="checkbox"/> Spouses' Co-ownership	<input type="checkbox"/> Registered Domestic Partnership	<input type="checkbox"/> General Partnership	<input type="checkbox"/> Limited Partnership	<input type="checkbox"/> Other: (describe)
1. Name of Sole Owner, Corporation, Partnership, Institute, Other. Life Technologies Corporation				
2. Business Trade Name ("Doing Business As," if any) None				
3. Business Address (physical location of your business: street number and name, city, state, country, zip or postal code) 5791 Van Allen Way, Carlsbad, California 92008, USA				
4. Mailing Address (street name and number, P.O. box, city, state, country, zip or postal code, if different from 3) The Same as Above				
5. Business Website Address(es): http://www.lifetechnologies.com				
6. Name of Owner, Responsible Corporate Officer, Partner, Other. Sang-Tae Kim				
7. Contact Information for Person in 6 above.				
Name: Sang-Tae Kim		Title: Manager, Design-for-Environment/EHS		
Business Telephone: 650-554-2798		Email: sang-tae.kim@lifetech.com		
8. Number of Employees (California employees). 2908				
9. NAICS Code(s) for this business:		Primary: 325413	Other:	Other:
10. Nano Chemical Business Type: (check applicable)		<input checked="" type="checkbox"/> Manufacturer	<input checked="" type="checkbox"/> Importer	<input checked="" type="checkbox"/> Researcher

SECTION C: CERTIFICATION (FOR THIS COMPLETE SUBMITTAL)		
I am fully authorized to prepare and submit this information, as a formal response to the request pursuant to Health and Safety Code section 57019(d)(1), and certify the information and statements made herein, and in the attachments, are correct to the best of my knowledge and belief.		
Name: (type or print) Sang-Tae Kim	Signature: 	Date: December 15, 2011

SECTION D: NANOMATERIAL CHEMICAL AND PHYSICAL PROPERTIES (Attach additional pages as needed)		
PRODUCT / PRODUCTION INFORMATION		
NANO CHEMICAL NAME: WesternDot™ Western Blot Kit		
COMMERCIAL NAME(S): WesternDot™ 625 Goat Anti-Mouse Western Blot Kit; WesternDot™ 625 Goat Anti-Rabbit Western Blot Kit		
ANNUAL PRODUCTION VOLUME: Total annual production is 0.429 grams. Quantity shipped to California is 0.011 grams.		
PRODUCTION METHOD(S): Core and core-shell nanoparticles are produced using common colloidal synthesis techniques. Some examples may be found in the following patents: 6,322,901; 6,815,064; 7,147,712; 7,695,642. Some examples of methods for applying the amphiphilic coating to these particles to render them water soluble may be found in the following patent 6,649,138.		
IDENTIFICATION OF THE SUPPLIER(S): Life Technologies is the producer and supplier of these products.		
PARAMETER	VALUE / RANGE	NAME OF ANALYTICAL METHOD(S)
PHYSICAL PROPERTIES		
SHAPE (MORPHOLOGY)	The morphology of a nanoparticle is most commonly measured by transmission electron microscopy (TEM) since it is the only analytical technique with resolution sufficient to resolve the fine features of a nanoparticle. This technique is limited, however, since it is most sensitive to electron dense elements of the nanoparticle like cadmium, zinc and selenium and virtually insensitive to lighter elements like carbon, hydrogen, oxygen and nitrogen. This means that shape and morphology information is not available for nanoparticles that comprise organic coatings. In other words, TEM can only give you information about the nanocrystal within a nanoparticle. TEM is further limited by the fact that the data acquired is only a two dimensional projection of the three dimensional shape. Therefore to calculate the volume or surface area, a three dimensional shape must be assumed. The size of the nanoparticle (nanocrystal and organic ligands) can be measured by size exclusion chromatography (SEC) but this technique does not have the resolution to provide morphology information.	
DENSITY	The density of these materials has not been measured	
SURFACE AREA	Since we cannot measure the morphology of WesternDot™ Western Blot Kit nanoparticles, we cannot calculate the surface area. If we approximate the morphology as a sphere and use the SEC sizing data, we can calculate a spherical surface area.	
PARTICLE SIZE DISTRIBUTION	Air	To the best of our knowledge, no technique is currently available
	Liquid	Dynamic light scattering can give particle size distribution data, however, several complications exist in interpreting the data. Some of those caveats include, (1) since quantum dots have broad absorbance, any color that emits at longer wavelengths than the laser will absorb some of the laser light and make interpretation of the data nearly impossible, (2) large particles scatter much more efficiently than smaller particles making detection of small particle populations difficult.
	Solid/ Powder	To the best of our knowledge, no technique is currently available
OTHER (SPECIFY)		
CHEMICAL PROPERTIES		
CHEMICAL COMPOSITION	The inorganic portion of the nanoparticles (nanocrystal) is composed of cadmium, selenium, zinc and sulfur. The exact composition of the ligand shell is unknown but NMR	The chemical composition of this polymer is best

		has revealed that it is mostly composed of tetradecylphosphonic acid (TDPA) and/or other phosphorus-containing species. The polymer coating is an amphiphilic molecule that is associated with the nanoparticle and provides water solubility. The polyethylene glycol (PEG) coating is attached to the polymer coating through amide bonds created by reacting amine-functional PEG molecules with carbodiimide (e.g., 1-Ethyl-3-[3-dimethylaminopropyl]carbodiimide hydrochloride) activated carboxylate groups on the polymer coating. The particle surface is then made amine reactive by reacting a homobifunctional crosslinker (e.g., Bis[sulfosuccinimidyl] suberate) to residual amine functional groups on the terminal ends of the PEG molecules. The crosslinker is attached to the quantum dot through an amide bond. Lastly, the amine reactive quantum dots are incubated with streptavidin. Amide bonds are formed between the quantum dot and streptavidin.	described in Patent Number 6,649,138
SURFACE MODIFICATION (COATING, FUNCTIONALIZATION)		The outer surface contains an amphiphilic polymer, polyethylene glycol and streptavidin.	The process of applying this polymer to the nanoparticles is best described in patent number 6,649,138.
PURITY		Purity is essential for our products. We have most routinely use SEC to detect and measure impurities. Some of those impurities include aggregated nanoparticles, free (unbound) amphiphilic polymer, and other nanoparticle impurities.	
SURFACE CHARGE		We routinely perform gel electrophoresis to confirm the charge of a particle but we do not quantitate it in terms of charge density.	
DISPERSION	Air	We do not handle air dispersions in our operations or R&D	
	Liquid	Presence of aggregated particles is routinely measured by SEC chromatography. In fact, all of our products and water soluble intermediates have specifications around the percentage of these soluble aggregates present in the solution.	
	Solid	We do not handle the materials in the solid form, but as a liquid dispersion.	
IDENTIFYING AND DETERMINING CONCENTRATION OF NANO CHEMICAL, ITS METABOLITES, AND DEGRADATION PRODUCTS IN SPECIFIED MATRICES (Water, Air, Soil, Sediment, Sludge, Chemical Waste, Fish, Blood, Adipose Tissue, Urine, Other)		Determining the exact concentration of nanoparticles in any matrix is difficult because routine nanoparticle counting techniques do not currently exist. The most common method for determining the concentration of quantum dots is to measure the optical absorbance in solution at a concentration where Beer's law is operative and calculate the concentration using an estimated extinction coefficient for the material.	A example of a common technique for estimating the extinction coefficient for quantum dot can be found in this reference (Chem. Mater. 2003, 15, 2854-2860)
SOLUBILITY	Water Solubility	Soluble/miscible in water. These products are sold at a concentration of 1 micromolar which is in the range of 0.06 mg/mL to 1 mg/mL depending on the color.	
	Solubility in Organic Solvent	Not soluble/miscible in organic solvent	
N-OCTANOL-WATER PARTITION COEFFICIENT		We have not measured this parameter.	
STABILITY	Flammability	These nanoparticle products are sold as dilute (1 μ M or	

AND REACTIVITY		approximately 0.06 mg to 1 mg/mL) aqueous solutions and are therefore classified with a HMIS flammability rating of 0 (same as water).	
	Explosiveness	These products do not pose an explosion hazard. This conclusion is partially based on thermogravimetric analysis (TGA) of our ITK organic quantum dots. TGA shows that no weight loss occurs until about 300 °C. At around 300 °C the particles lose about 10 - 20 % of their mass. This temperature coincides with the boiling point of the organic ligands used in the synthesis of quantum dots. No other weight loss is observed up to a temperature of 650 °C.	
	Oxidizing Properties	These products are not strong oxidizing agents.	
	Oxidation Reduction Potential	These products are not strong reducing agents.	
	Storage Stability and Reactivity (Container Material)	These products are stable in a variety of container materials including, glass and plastic. The product is packaged and shipped in polypropylene vials.	
	Stability to Thermal, Sunlight, and Metal(s)	These products are stable, meaning that they will work for their intended purpose, to multiple rounds of freezing and thawing and moderately high temperatures (0 °C to 37 °C). These products are stable and will work for their intended purpose with moderate sunlight exposure. Some metals will quench the florescence from these particles. Particularly copper (II) and iron (III).	Reference - Cytometry Part A, 79A: 84 89, 2011

SECTION E: Provide a copy of your Globally Harmonized System (GHS) Safety Data Sheet (SDS), if you have prepared one.

Attached is current SDS/Material Safety Data Sheet (MSDS). See Attachment 1

SECTION F: For each nanomaterial you produce or import, describe the analytical test method(s) that you use, or plan to use, to sample, prepare, and analyze a specific matrix to determine the identity and concentration of each specified nanomaterial. Use a separate page to describe the procedure for each, individual matrix, which must include water, air, soil, sediment, sludge, chemical waste, fish, blood, adipose tissue, and urine. Include the information requested in Section D above.

Life Technologies' *Medical Surveillance and Monitoring Plan* requires a bi-annual monitoring of blood and urine samples as well as an annual physical examination of employees who are involved in manufacturing of quantum dots. No cadmium was detectable from either blood or urine samples, when analyzed with the use of Inductively Coupled Plasma/Mass Spectrometry (ICP-MS) (see <http://www.aruplab.com/guides/ug/tests/0025040.jsp> for detailed information on sampling and analysis methodology).

We have not determined the identity and concentration of WesternDot™ Western Blot Kit nanocrystals in environmental matrix including air, soil, sediment, sludge, chemical waste, fish, and adipose tissue.

ATTACHMENT 1

**MATERIAL SAFETY DATA SHEET
(Sample)**



SAFETY DATA SHEET

1. Identification of the substance/mixture and of the company/undertaking

Identification of the substance/preparation

Product code W10132COMPONENTC
Product name Biotin-XX Goat Anti-Mouse IgG (H+L) *2 mg/mL*

Company/Undertaking Identification

Life Technologies
5791 VAN ALLEN WAY
PO BOX 6482
CARLSBAD, CA 92008
+1 760 603 7200

INVITROGEN CORPORATION
5250 MAINWAY DRIVE
BURLINGTON, ONT
CANADA L7L 6A4
800/263-6236

24 hour Emergency Response (Transport):

866-536-0631
301-431-8585
Outside of the U.S. +1-301-431-8585

For research use only. Not intended for human or animal diagnostic or therapeutic uses.

Revision Date 29-Nov-2011
Product code W10132COMPONENTC

Page 1 / 8
Product name Biotin-XX Goat Anti-Mouse IgG (H+L) *2 mg/mL*

www.lifetechnologies.com

2. Hazards identification**GHS - Classification****Signal Word**
not hazardous**Health Hazard**
not hazardous**Physical Hazards**
not hazardous**Principle Routes of Exposure/****Potential Health effects**

Eyes	May cause eye irritation with susceptible persons.
Skin	May cause skin irritation in susceptible persons.
Inhalation	May be harmful by inhalation.
Ingestion	May be harmful if swallowed.

Specific effects

Carcinogenic effects	none.
Mutagenic effects	none.
Reproductive toxicity	none.
Sensitization	none.

Target Organ Effects	No known effects under normal use conditions
-----------------------------	--

HMIS

Health	0
Flammability	0
Reactivity	0

3. Composition/information on ingredients

Chemical Name	CAS-No	EINECS-No	Weight %
Sodium azide	28628-22-8	247-852-1	<0.1

The product contains no substances which at their given concentration, are considered to be hazardous to health. We recommend handling all chemicals with caution.

Revision Date 20-Nov-2011
Product code W10132COMPONENTC

Page 2 / 6
Product name Biotin-XX Goat Anti-Mouse IgG (H+L) *2 mg/mL*

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4. First aid measures

Skin contact	Rinse with plenty of water. If symptoms arise, call a physician.
Eye contact	Rinse immediately with plenty of water, also under the eyelids, for at least 15 minutes. If symptoms persist, call a physician.
Ingestion	Never give anything by mouth to an unconscious person. If symptoms persist, call a physician. Do not induce vomiting without medical advice.
Inhalation	Move to fresh air. If symptoms persist, call a physician. If not breathing, give artificial respiration.
Notes to physician	Treat symptomatically.

5. Fire-fighting measures

Suitable extinguishing media	Water spray. Carbon dioxide (CO ₂). Foam. Dry chemical.
Special protective equipment for firefighters	Wear self-contained breathing apparatus and protective suit.

6. Accidental release measures

Personal precautions	Use personal protective equipment.
Methods for cleaning up	Soak up with inert absorbent material.

Environmental precautions

Prevent further leakage or spillage if safe to do so.

See Section 12 for additional information.

7. Handling and storage

Handling	Always wear recommended Personal Protective Equipment. No special handling advice required.
Storage	Keep in a dry, cool and well-ventilated place.

8. Exposure controls/personal protection

Exposure limits

Engineering measures	Ensure adequate ventilation, especially in confined areas.
-----------------------------	--

Personal protective equipment

Respiratory protection	In case of insufficient ventilation wear suitable respiratory equipment.
-------------------------------	--

Hand protection	Impervious gloves.
Eye protection	Safety glasses with side-shields.
Skin and body protection.	Lightweight protective clothing.
Hygiene measures	Handle in accordance with good industrial hygiene and safety practice.

Environmental exposure controls	Prevent product from entering drains.
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Revision Date 29-Nov-2011
 Product code W10132COMPONENTC

Page 3 / 8
 Product name Biotin-XX Goat Anti-Mouse IgG (H+L) *2 mg/mL*

www.lifetechnologies.com

9. Physical and chemical properties**General Information**

Form	liquid	
Appearance	No information available	
Odor	No information available	
Boiling Point/Range	°C no data available	°F no data available
Melting point/range	°C no data available	°F no data available
Flash point	°C no data available	°F no data available
Autoignition temperature	°C no data available	°F no data available
Oxidizing properties	No information available.	
Water solubility	soluble	
pH VALUE	7.5	

10. Stability and reactivity

Stability	Stable under normal conditions.
Materials to avoid	No dangerous reaction known under conditions of normal use.
Hazardous decomposition products	None under normal use
polymerization	Hazardous polymerisation does not occur.

11. Toxicological information**Acute toxicity**

Chemical Name	LD50 (oral, rat/mouse)	LD50 (dermal, rat/rabbit)	LC50 (inhalation, rat/mouse)
Sodium azide	= 27 mg/kg (Rat)	no data available	no data available

Principle Routes of Exposure/**Potential Health effects**

Eyes	May cause eye irritation with susceptible persons.
Skin	May cause skin irritation in susceptible persons.
Inhalation	May be harmful by inhalation.
Ingestion	May be harmful if swallowed.
Carcinogenic effects	none
Mutagenic effects	none
Reproductive toxicity	none
Sensitization	none
Target Organ Effects	No known effects under normal use conditions

12. Ecological information

Ecotoxicity effects	No information available.
Mobility	No information available.
Biodegradation	Inherently biodegradable

Revision Date 29-Nov-2011
 Product code W10132COMPONENTC

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 Product name Biotin-XX Goat Anti-Mouse IgG (H+L) *2 mg/ml*

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Bioaccumulation Does not bioaccumulate.

13. Disposal considerations

Dispose of in accordance with local regulations.

14. Transport information

IATA

Proper shipping name	Not classified as dangerous in the meaning of transport regulations
Hazard class	none
Subsidiary Class	none
Packing group	none
UN-No	None

15. Regulatory information

Component	TSCA
Sodium azide 26628-22-8 (<0.1)	Listed

U.S. Federal Regulations

SARA 313

This product contains the following toxic chemical(s) subject to the notification requirements of section 313 of Title III of the Superfund Amendments and Reauthorization Act of 1986. This law requires certain manufacturers to report on annual emissions of specified chemicals and chemical categories. Please note that if you repackage, or otherwise redistribute, this product to industrial customers, a notice similar to this one should be sent to those customers:

Chemical Name	CAS-No	Weight %	SARA 313 - Threshold Values
Sodium azide	26628-22-8	<0.1	1.0

Clean Air Act, Section 112 Hazardous Air Pollutants (HAPs) (see 40 CFR 61)

This product does not contain HAPs.

U.S. State Regulations

Chemical Name	Massachusetts - RTK	New Jersey - RTK	Pennsylvania - RTK	Illinois - RTK	Rhode Island - RTK
Sodium azide	Listed	Listed	Listed	-	Listed

California Proposition 65

This product does not contain chemicals listed under Proposition 65

WHMIS hazard class:

Non-controlled

This product has been classified according to the hazard criteria of the CPR and the MSDS contains all of the information required by the CPR

16. Other information

Reason for Revision (M)SDS sections updated.

Revision Date 28-Nov-2011
Product code W10132COMPONENTC

Page 5/8
Product name Biotin-XX Goat Anti-Mouse IgG (H+L) *2 mg/ml*

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For research use only. Not intended for human or animal diagnostic or therapeutic uses.

The above information was acquired by diligent search and/or investigation and the recommendations are based on prudent application of professional judgment. The information shall not be taken as being all inclusive and is to be used only as a guide. All materials and mixtures may present unknown hazards and should be used with caution. Since the Company cannot control the actual methods, volumes, or conditions of use, the Company shall not be held liable for any damages or losses resulting from the handling or from contact with the product as described herein. THE INFORMATION IN THIS MSDS DOES NOT CONSTITUTE A WARRANTY, EXPRESSED OR IMPLIED, INCLUDING ANY IMPLIED WARRANTY OF MERCHANTABILITY OR FITNESS FOR ANY PARTICULAR PURPOSE.

End of Safety Data Sheet

Revision Date 29-Nov-2011
Product code W1D132COMPONENTC

Page 6 / 6
Product name Biotin-XX Goat Anti-Mouse IgG (H+L) *2 mg/mL*

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STATE OF CALIFORNIA
Department of Toxic Substances Control

Health and Safety Code Section 57019 Chemical Information Call-in Information
For Nanometals, Nanometal Oxides, and Quantum Dots
December 2010

This enclosure is provided for your convenience. You may provide the requested information in writing, and attaching any supplementary materials or explanatory information, in letter or report form.

SECTION A: CHEMICAL(S) (Check each one which applies for your company)		
<input type="checkbox"/> Nano Silver	<input type="checkbox"/> Nano Titanium Dioxide	<input type="checkbox"/> Nano Cerium Oxide
<input type="checkbox"/> Nano Zero Valent Iron	<input type="checkbox"/> Nano Zinc Oxide	<input checked="" type="checkbox"/> Quantum Dot(s)

SECTION B: BUSINESS IDENTIFICATION INFORMATION (check one and complete 1 – 10)				
<input type="checkbox"/> Sole Owner	<input checked="" type="checkbox"/> Corporation	<input type="checkbox"/> Limited Liability Company (LLC)	<input type="checkbox"/> Limited Liability Partnership (LLP)	<input type="checkbox"/> Unincorporated Business Trust
<input type="checkbox"/> Spouses' Co-ownership	<input type="checkbox"/> Registered Domestic Partnership	<input type="checkbox"/> General Partnership	<input type="checkbox"/> Limited Partnership	<input type="checkbox"/> Other: (describe)
1. Name of Sole Owner, Corporation, Partnership, Institute, Other. Life Technologies Corporation				
2. Business Trade Name ("Doing Business As," if any) None				
3. Business Address (physical location of your business: street number and name, city, state, country, zip or postal code) 5791 Van Allen Way, Carlsbad, California 92008, USA				
4. Mailing Address (street name and number, P.O. box, city, state, country, zip or postal code, if different from 3) The Same as Above				
5. Business Website Address(es): http://www.lifetechnologies.com				
6. Name of Owner, Responsible Corporate Officer, Partner, Other. Sang-Tae Kim				
7. Contact Information for Person in 6 above.				
Name: Sang-Tae Kim		Title: Manager, Design-for-Environment/EHS		
Business Telephone: 650-554-2798		Email: sang-tae.kim@lifetech.com		
8. Number of Employees (California employees). 2908				
9. NAICS Code(s) for this business:		Primary: 325413	Other:	Other:
10. Nano Chemical Business Type: (check applicable)		<input checked="" type="checkbox"/> Manufacturer	<input checked="" type="checkbox"/> Importer	<input checked="" type="checkbox"/> Researcher

SECTION C: CERTIFICATION (FOR THIS COMPLETE SUBMITTAL)		
I am fully authorized to prepare and submit this information, as a formal response to the request pursuant to Health and Safety Code section 57019(d)(1), and certify the information and statements made herein, and in the attachments, are correct to the best of my knowledge and belief.		
Name: (type or print) Sang-Tae Kim	Signature: 	Date: December 15, 2011

SECTION D: NANOMATERIAL CHEMICAL AND PHYSICAL PROPERTIES (Attach additional pages as needed)		
PRODUCT / PRODUCTION INFORMATION		
NANO CHEMICAL NAME: Qtracker® Cell Labeling Kit		
COMMERCIAL NAME(S): Qtracker® 525 Cell Labeling Kit; Qtracker® 565 Cell Labeling Kit; Qtracker® 585 Cell Labeling Kit; Qtracker® 605 Cell Labeling Kit; Qtracker® 625 Cell Labeling Kit; Qtracker® 655 Cell Labeling Kit; Qtracker® 705 Cell Labeling Kit; Qtracker® 800 Cell Labeling Kit		
ANNUAL PRODUCTION VOLUME: Total annual production is 0.988 gram. Quantity shipped to California is 0.031 gram.		
PRODUCTION METHOD(S): Core and core-shell nanoparticles are produced using common colloidal synthesis techniques. Some examples may be found in the following patents: 6,322,901; 6,815,064; 7,147,712; 7,695,642. Some examples of methods for applying the amphiphilic coating to these particles to render them water soluble may be found in the following patent 6,649,138.		
IDENTIFICATION OF THE SUPPLIER(S): Life Technologies is the producer and supplier of these products.		
PARAMETER	VALUE / RANGE	NAME OF ANALYTICAL METHOD(S)
PHYSICAL PROPERTIES		
SHAPE (MORPHOLOGY)	The morphology of a nanoparticle is most commonly measured by transmission electron microscopy (TEM) since it is the only analytical technique with resolution sufficient to resolve the fine features of a nanoparticle. This technique is limited, however, since it is most sensitive to electron dense elements of the nanoparticle like cadmium, zinc and selenium and virtually insensitive to lighter elements like carbon, hydrogen, oxygen and nitrogen. This means that shape and morphology information is not available for nanoparticles that comprise organic coatings. In other words, TEM can only give you information about the nanocrystal within a nanoparticle. TEM is further limited by the fact that the data acquired is only a two dimensional projection of the three dimensional shape. Therefore to calculate the volume or surface area, a three dimensional shape must be assumed. The size of the nanoparticle (nanocrystal and organic ligands) can be measured by size exclusion chromatography (SEC) but this technique does not have the resolution to provide morphology information.	
DENSITY	The density of these materials has not been measured	
SURFACE AREA	Since we cannot measure the morphology of Qtracker® Cell Labeling Kit nanoparticles, we cannot calculate the surface area. If we approximate the morphology as a sphere and use the SEC sizing data, we can calculate a spherical surface area.	
PARTICLE SIZE DISTRIBUTION	Air	To the best of our knowledge, no technique is currently available
	Liquid	Dynamic light scattering can give particle size distribution data, however, several complications exist in interpreting the data. Some of those caveats include, (1) since quantum dots have broad absorbance, any color that emits at longer wavelengths than the laser will absorb some of the laser light and make interpretation of the data nearly impossible, (2) large particles scatter much more efficiently than smaller particles making detection of small particle populations difficult.
	Solid/ Powder	To the best of our knowledge, no technique is currently available
OTHER (SPECIFY)		
CHEMICAL PROPERTIES		
CHEMICAL COMPOSITION	The inorganic portion of the nanoparticles (nanocrystal) is composed of cadmium, selenium, zinc and sulfur. Two of	The chemical composition of this

		our nanocrystal products (Qdot 705 and 800) additionally contain tellurium. The exact composition of the ligand shell is unknown but NMR has revealed that it is mostly composed of tetradecylphosphonic acid (TDPA) and/or other phosphorus-containing species. The polymer coating is an amphiphilic molecule that is associated with the nanoparticle and provides water solubility. Streptavidin is incubated with carbodiimide (e.g., 1-Ethyl-3-[3-dimethylaminopropyl]carbodiimide hydrochloride) activated polymer coated quantum dots to allow amine residues on streptavidin to form amide bonds to the polymer coating.	polymer is best described in Patent Number 6,649,138
SURFACE MODIFICATION (COATING, FUNCTIONALIZATION)		The outer surface contains an amphiphilic polymer, streptavidin.	The process of applying this polymer to the nanoparticles is best described in patent number 6,649,138.
PURITY		Purity is essential for our products. We have most routinely use SEC to detect and measure impurities. Some of those impurities include aggregated nanoparticles, free (unbound) amphiphilic polymer, and other nanoparticle impurities.	
SURFACE CHARGE		We routinely perform gel electrophoresis to confirm the charge of a particle but we do not quantitate it in terms of charge density.	
DISPERSION	Air	We do not handle air dispersions in our operations or R&D	
	Liquid	Presence of aggregated particles is routinely measured by SEC chromatography. In fact, all of our products and water soluble intermediates have specifications around the percentage of these soluble aggregates present in the solution.	
	Solid	We do not handle the materials in the solid form, but as a liquid dispersion.	
IDENTIFYING AND DETERMINING CONCENTRATION OF NANO CHEMICAL, ITS METABOLITES, AND DEGRADATION PRODUCTS IN SPECIFIED MATRICES (Water, Air, Soil, Sediment, Sludge, Chemical Waste, Fish, Blood, Adipose Tissue, Urine, Other)		Determining the exact concentration of nanoparticles in any matrix is difficult because routine nanoparticle counting techniques do not currently exist. The most common method for determining the concentration of quantum dots is to measure the optical absorbance in solution at a concentration where Beer's law is operative and calculate the concentration using an estimated extinction coefficient for the material.	A example of a common technique for estimating the extinction coefficient for quantum dot can be found in this reference (Chem. Mater. 2003, 15, 2854-2860)
SOLUBILITY	Water Solubility	Soluble/miscible in water. These products are sold at a concentration of 4 micromolar which is in the range of 0.25 mg/mL to 4 mg/mL depending on the color.	
	Solubility in Organic Solvent	Not soluble/miscible in organic solvent	
N-OCTANOL-WATER PARTITION COEFFICIENT		We have not measured this parameter.	
STABILITY AND REACTIVITY	Flammability	These nanoparticle products are sold as dilute (4 µM or approximately 0.25 mg to 4 mg/mL) aqueous solutions and are therefore classified with a HMIS flammability rating of 0 (same as water).	
	Explosiveness	These products do not pose an explosion hazard. This conclusion is partially based on thermogravimetric analysis (TGA) of our ITK organic quantum dots. TGA shows that no weight loss occurs until about 300 °C. At around 300	

		°C the particles lose about 10 - 20 % of their mass. This temperature coincides with the boiling point of the organic ligands used in the synthesis of quantum dots. No other weight loss is observed up to a temperature of 650 °C.	
	Oxidizing Properties	These products are not strong oxidizing agents.	
	Oxidation Reduction Potential	These products are not strong reducing agents.	
	Storage Stability and Reactivity (Container Material)	These products are stable in a variety of container materials including, glass and plastic. The product is packaged and shipped in polypropylene vials.	
	Stability to Thermal, Sunlight, and Metal(s)	These products are stable, meaning that they will work for their intended purpose, to multiple rounds of freezing and thawing and moderately high temperatures (0 °C to 37 °C). These products are stable and will work for their intended purpose with moderate sunlight exposure. Some metals will quench the florescence from these particles. Particularly copper (II) and iron (III).	Reference - Cytometry Part A, 79A: 84 89, 2011

SECTION E: Provide a copy of your Globally Harmonized System (GHS) Safety Data Sheet (SDS), if you have prepared one.
 Attached is current SDS/Material Safety Data Sheet (MSDS). See Attachment 1

SECTION F: For each nanomaterial you produce or import, describe the analytical test method(s) that you use, or plan to use, to sample, prepare, and analyze a specific matrix to determine the identity and concentration of each specified nanomaterial. Use a separate page to describe the procedure for each, individual matrix, which must include water, air, soil, sediment, sludge, chemical waste, fish, blood, adipose tissue, and urine. Include the information requested in Section D above.

Life Technologies' *Medical Surveillance and Monitoring Plan* requires a bi-annual monitoring of blood and urine samples as well as an annual physical examination of employees who are involved in manufacturing of quantum dots. No cadmium was detectable from either blood or urine samples, when analyzed with the use of Inductively Coupled Plasma/Mass Spectrometry (ICP-MS) (see <http://www.aruplab.com/guides/ug/tests/0025040.jsp> for detailed information on sampling and analysis methodology).

We have not determined the identity and concentration of Qtracker® Cell Labeling Kit nanocrystals in environmental matrix including air, soil, sediment, sludge, chemical waste, fish, and adipose tissue.

ATTACHMENT 1
MATERIAL SAFETY DATA SHEET
(Sample)



SAFETY DATA SHEET

1. Identification of the substance/mixture and of the company/undertaking

Identification of the substance/preparation

Product code Q25041MPCOMPONENTA
Product name Qtracker® 525

Company/Undertaking Identification

Life Technologies
5791 VAN ALLEN WAY
PO BOX 6482
CARLSBAD, CA 92008
+1 760 603 7200

INVITROGEN CORPORATION
5250 MAINWAY DRIVE
BURLINGTON, ONT
CANADA L7L 6A4
800/263-6236

24 hour Emergency Response (Transport):

866-536-0631
301-431-8585
Outside of the U.S. +1-301-431-8585

For research use only. Not intended for human or animal diagnostic or therapeutic uses.

Revision Date 29-Nov-2011
Product code Q25041MPCOMPONENTA

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Product name Qtracker® 525

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2. Hazards identification

GHS - Classification

Signal Word
not hazardous

Health Hazard
not hazardous

Physical Hazards
not hazardous

**Principle Routes of Exposure/
Potential Health effects**

Eyes	May cause eye irritation with susceptible persons.
Skin	May cause skin irritation in susceptible persons.
Inhalation	May be harmful by inhalation.
Ingestion	May be harmful if swallowed.

Specific effects

Carcinogenic effects	none.
Mutagenic effects	none.
Reproductive toxicity	none.
Sensitization	none

Target Organ Effects No known effects under normal use conditions

HMIS

Health	0
Flammability	0
Reactivity	0

3. Composition/information on ingredients

The product contains no substances which at their given concentration, are considered to be hazardous to health. We recommend handling all chemicals with caution.

4. First aid measures

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Product code Q25041MPCOMPONENTA

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Product name Qtracker® 525

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Skin contact	Rinse with plenty of water. If symptoms arise, call a physician.
Eye contact	Rinse immediately with plenty of water, also under the eyelids, for at least 15 minutes. If symptoms persist, call a physician.
Ingestion	Never give anything by mouth to an unconscious person. If symptoms persist, call a physician. Do not induce vomiting without medical advice.
Inhalation	Move to fresh air. If symptoms persist, call a physician. If not breathing, give artificial respiration.
Notes to physician	Treat symptomatically.

5. Fire-fighting measures

Suitable extinguishing media	Water spray. Carbon dioxide (CO2). Foam. Dry chemical.
Special protective equipment for firefighters	Wear self-contained breathing apparatus and protective suit.

6. Accidental release measures

Personal precautions	Use personal protective equipment.
Methods for cleaning up	Soak up with inert absorbent material.

Environmental precautions

Prevent further leakage or spillage if safe to do so.

See Section 12 for additional information.

7. Handling and storage

Handling	Always wear recommended Personal Protective Equipment. No special handling advice required.
Storage	Keep in a dry, cool and well-ventilated place.

8. Exposure controls/personal protection

Exposure limits

At this time, the limited evidence available suggests caution when potential exposures to nanoparticles may occur. Due to the limited information about health risks from nanomaterials, it is prudent to take steps for minimizing worker exposures. Research is still needed to understand the impact of nanotechnology on health, and to determine appropriate exposure monitoring and control strategies.

Engineering measures	Ensure adequate ventilation, especially in confined areas.
-----------------------------	--

Personal protective equipment

Respiratory protection	In case of insufficient ventilation wear suitable respiratory equipment.
-------------------------------	--

Hand protection	Impervious gloves.
Eye protection	Safety glasses with side-shields.
Skin and body protection.	Lightweight protective clothing.
Hygiene measures	Handle in accordance with good industrial hygiene and safety practice.

Revision Date 29-Nov-2011
Product code Q2504-IMP-COMPONENTA

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Product name Qtracker® 525

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Environmental exposure controls

Prevent product from entering drains.

9. Physical and chemical properties

General Information

Form	suspension	
Appearance	liquid	
Odor	No information available	
Boiling Point/Range	°C no data available	°F no data available
Melting point/range	°C no data available	°F no data available
Flash point	°C no data available	°F no data available
Autoignition temperature	°C no data available	°F no data available
Oxidizing properties	No information available.	
Water solubility	soluble	
pH VALUE	8.3	

10. Stability and reactivity

Stability	Stable under normal conditions.
Materials to avoid	No dangerous reaction known under conditions of normal use.
Hazardous decomposition products	None under normal use
polymerization	Hazardous polymerisation does not occur.

11. Toxicological information

Acute toxicity

At this time, the limited evidence available suggests caution when potential exposures to nanoparticles may occur. Due to the limited information about health risks from nanomaterials, it is prudent to take steps for minimizing worker exposures. Occupational health risks associated with manufacturing and using nanomaterials are not yet clearly understood. Studies have indicated that low solubility nanoparticles are more toxic than larger particles on a mass for mass basis. There are strong indications that particle surface area and surface chemistry are responsible for observed responses in cell cultures and animals. There are indications that nanoparticles can penetrate through the skin or move from the respiratory system to other organs.

Principle Routes of Exposure/

Potential Health effects

Eyes	May cause eye irritation with susceptible persons.
Skin	May cause skin irritation in susceptible persons.
Inhalation	May be harmful by inhalation.
Ingestion	May be harmful if swallowed.
Carcinogenic effects	none
Mutagenic effects	none
Reproductive toxicity	none
Sensitization	none
Target Organ Effects	No known effects under normal use conditions

Revision Date 28-Nov-2011
 Product code Q25041MPCOMPONENTA

Page 4/8
 Product name Qtracker® 525

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12. Ecological information

Ecotoxicity effects	No information available.
Mobility	No information available.
Biodegradation	Inherently biodegradable
Bioaccumulation	Does not bioaccumulate.

13. Disposal considerations

Dispose of in accordance with local regulations.

14. Transport information

IATA

Proper shipping name	Not classified as dangerous in the meaning of transport regulations
Hazard class	none
Subsidiary Class	none
Packing group	none
UN-No	None

15. Regulatory information

U.S. Federal Regulations

SARA 313

This product contains the following toxic chemical(s) subject to the notification requirements of section 313 of Title III of the Superfund Amendments and Reauthorization Act of 1986. This law requires certain manufacturers to report on annual emissions of specified chemicals and chemical categories. Please note that if you repackage, or otherwise redistribute, this product to industrial customers, a notice similar to this one should be sent to those customers:

Clean Air Act, Section 112 Hazardous Air Pollutants (HAPs) (see 40 CFR 61)

This product does not contain HAPs.

U.S. State Regulations

California Proposition 65

This product does not contain chemicals listed under Proposition 65

WHMIS hazard class:

Non-controlled

This product has been classified according to the hazard criteria of the CPR and the MSDS contains all of the information required by the CPR

16. Other information

Reason for Revision (M)SDS sections updated.

Revision Date 29-Nov-2011
Product code Q2504 IMPCOMPONENTA

Page 5/6
Product name Qtracker® 525

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References

- National Institute for Occupational Safety and Health (NIOSH), U.S., 2010:
<http://www.cdc.gov/niosh/topics/nanotech/>
- National Institute for Occupational Safety and Health (NIOSH), U.S., 2009:
<http://www.cdc.gov/niosh/docs/2009-125/pdfs/2009-125.pdf>

The above information was acquired by diligent search and/or investigation and the recommendations are based on prudent application of professional judgment. The information shall not be taken as being all inclusive and is to be used only as a guide. All materials and mixtures may present unknown hazards and should be used with caution. Since the Company cannot control the actual methods, volumes, or conditions of use, the Company shall not be held liable for any damages or losses resulting from the handling or from contact with the product as described herein. THE INFORMATION IN THIS MSDS DOES NOT CONSTITUTE A WARRANTY, EXPRESSED OR IMPLIED, INCLUDING ANY IMPLIED WARRANTY OF MERCHANTABILITY OR FITNESS FOR ANY PARTICULAR PURPOSE.

End of Safety Data Sheet

Revision Date 29-Nov-2011
Product code Q25041MPCOMPONENTA

Page 6/8
Product name Qtracker® 525

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STATE OF CALIFORNIA
Department of Toxic Substances Control

Health and Safety Code Section 57019 Chemical Information Call-in Information
For Nanometals, Nanometal Oxides, and Quantum Dots
December 2010

This enclosure is provided for your convenience. You may provide the requested information in writing, and attaching any supplementary materials or explanatory information, in letter or report form.

SECTION A: CHEMICAL(S) (Check each one which applies for your company)		
<input type="checkbox"/> Nano Silver	<input type="checkbox"/> Nano Titanium Dioxide	<input type="checkbox"/> Nano Cerium Oxide
<input type="checkbox"/> Nano Zero Valent Iron	<input type="checkbox"/> Nano Zinc Oxide	<input checked="" type="checkbox"/> Quantum Dot(s)

SECTION B: BUSINESS IDENTIFICATION INFORMATION (check one and complete 1 - 10)				
<input type="checkbox"/> Sole Owner	<input checked="" type="checkbox"/> Corporation	<input type="checkbox"/> Limited Liability Company (LLC)	<input type="checkbox"/> Limited Liability Partnership (LLP)	<input type="checkbox"/> Unincorporated Business Trust
<input type="checkbox"/> Spouses' Co-ownership	<input type="checkbox"/> Registered Domestic Partnership	<input type="checkbox"/> General Partnership	<input type="checkbox"/> Limited Partnership	<input type="checkbox"/> Other: (describe)
1. Name of Sole Owner, Corporation, Partnership, Institute, Other. Life Technologies Corporation				
2. Business Trade Name ("Doing Business As," if any) None				
3. Business Address (physical location of your business: street number and name, city, state, country, zip or postal code) 5791 Van Allen Way, Carlsbad, California 92008, USA				
4. Mailing Address (street name and number, P.O. box, city, state, country, zip or postal code, if different from 3) The Same as Above				
5. Business Website Address(es): http://www.lifetechnologies.com				
6. Name of Owner, Responsible Corporate Officer, Partner, Other. Sang-Tae Kim				
7. Contact Information for Person in 6 above.				
Name: Sang-Tae Kim		Title: Manager, Design-for-Environment/EHS		
Business Telephone: 650-554-2798		Email: sang-tae.kim@lifetech.com		
8. Number of Employees (California employees). 2908				
9. NAICS Code(s) for this business:		Primary: 325413	Other:	Other:
10. Nano Chemical Business Type: (check applicable)		<input checked="" type="checkbox"/> Manufacturer	<input checked="" type="checkbox"/> Importer	<input checked="" type="checkbox"/> Researcher

SECTION C: CERTIFICATION (FOR THIS COMPLETE SUBMITTAL)		
I am fully authorized to prepare and submit this information, as a formal response to the request pursuant to Health and Safety Code section 57019(d)(1), and certify the information and statements made herein, and in the attachments, are correct to the best of my knowledge and belief.		
Name: (type or print) Sang-Tae Kim	Signature: 	Date: December 15, 2011

SECTION D: NANOMATERIAL CHEMICAL AND PHYSICAL PROPERTIES (Attach additional pages as needed)		
PRODUCT / PRODUCTION INFORMATION		
NANO CHEMICAL NAME: Qdot® ITK Streptavidin Conjugate Kit		
COMMERCIAL NAME(S): Qdot® 525 ITK Streptavidin Conjugate Kit; Qdot® 545 ITK Streptavidin Conjugate Kit; Qdot® 565 ITK Streptavidin Conjugate Kit; Qdot® 585 ITK Streptavidin Conjugate Kit; Qdot® 605 ITK Streptavidin Conjugate Kit; Qdot® 655 ITK Streptavidin Conjugate Kit; Qdot® 705 ITK Streptavidin Conjugate Kit; Qdot® 800 ITK Streptavidin Conjugate Kit		
ANNUAL PRODUCTION VOLUME: Total annual production is 0.342 gram. Quantity shipped to California is 0.019 gram.		
PRODUCTION METHOD(S): Core and core-shell nanoparticles are produced using common colloidal synthesis techniques. Some examples may be found in the following patents: 6,322,901; 6,815,064; 7,147,712; 7,695,642. Some examples of methods for applying the amphiphilic coating to these particles to render them water soluble may be found in the following patent 6,649,138.		
IDENTIFICATION OF THE SUPPLIER(S): Life Technologies is the producer and supplier of these products.		
PARAMETER	VALUE / RANGE	NAME OF ANALYTICAL METHOD(S)
PHYSICAL PROPERTIES		
SHAPE (MORPHOLOGY)	The morphology of a nanoparticle is most commonly measured by transmission electron microscopy (TEM) since it is the only analytical technique with resolution sufficient to resolve the fine features of a nanoparticle. This technique is limited, however, since it is most sensitive to electron dense elements of the nanoparticle like cadmium, zinc and selenium and virtually insensitive to lighter elements like carbon, hydrogen, oxygen and nitrogen. This means that shape and morphology information is not available for nanoparticles that comprise organic coatings. In other words, TEM can only give you information about the nanocrystal within a nanoparticle. TEM is further limited by the fact that the data acquired is only a two dimensional projection of the three dimensional shape. Therefore to calculate the volume or surface area, a three dimensional shape must be assumed. The size of the nanoparticle (nanocrystal and organic ligands) can be measured by size exclusion chromatography (SEC) but this technique does not have the resolution to provide morphology information.	
DENSITY	The density of these materials has not been measured	
SURFACE AREA	Since we cannot measure the morphology of Qdot® ITK Streptavidin Conjugate Kit nanoparticles, we cannot calculate the surface area. If we approximate the morphology as a sphere and use the SEC sizing data, we can calculate a spherical surface area.	
PARTICLE SIZE DISTRIBUTION	Air	To the best of our knowledge, no technique is currently available
	Liquid	Dynamic light scattering can give particle size distribution data, however, several complications exist in interpreting the data. Some of those caveats include, (1) since quantum dots have broad absorbance, any color that emits at longer wavelengths than the laser will absorb some of the laser light and make interpretation of the data nearly impossible, (2) large particles scatter much more efficiently than smaller particles making detection of small particle populations difficult.
	Solid/ Powder	To the best of our knowledge, no technique is currently available
OTHER (SPECIFY)		
CHEMICAL PROPERTIES		
CHEMICAL COMPOSITION	The inorganic portion of the nanoparticles (nanocrystal) is	The chemical

		composed of cadmium, selenium, zinc and sulfur. Two of our nanocrystal products (Qdot 705 and 800) additionally contain tellurium. The exact composition of the ligand shell is unknown but NMR has revealed that it is mostly composed of tetradecylphosphonic acid (TDPA) and/or other phosphorus-containing species. The polymer coating is an amphiphilic molecule that is associated with the nanoparticle and provides water solubility. Streptavidin is incubated with carbodiimide (e.g., 1-Ethyl-3-[3-dimethylaminopropyl]carbodiimide hydrochloride) activated polymer coated quantum dots to allow amine residues on streptavidin to form amide bonds to the polymer coating.	composition of this polymer is best described in Patent Number 6,649,138
SURFACE MODIFICATION (COATING, FUNCTIONALIZATION)		The outer surface contains an amphiphilic polymer and streptavidin.	The process of applying this polymer to the nanoparticles is best described in patent number 6,649,138.
PURITY		Purity is essential for our products. We have most routinely use SEC to detect and measure impurities. Some of those impurities include aggregated nanoparticles, free (unbound) amphiphilic polymer, and other nanoparticle impurities.	
SURFACE CHARGE		We routinely perform gel electrophoresis to confirm the charge of a particle but we do not quantitate it in terms of charge density.	
DISPERSION	Air	We do not handle air dispersions in our operations or R&D	
	Liquid	Presence of aggregated particles is routinely measured by SEC chromatography. In fact, all of our products and water soluble intermediates have specifications around the percentage of these soluble aggregates present in the solution.	
	Solid	We do not handle the materials in the solid form, but as a liquid dispersion.	
IDENTIFYING AND DETERMINING CONCENTRATION OF NANO CHEMICAL, ITS METABOLITES, AND DEGRADATION PRODUCTS IN SPECIFIED MATRICES (Water, Air, Soil, Sediment, Sludge, Chemical Waste, Fish, Blood, Adipose Tissue, Urine, Other)		Determining the exact concentration of nanoparticles in any matrix is difficult because routine nanoparticle counting techniques do not currently exist. The most common method for determining the concentration of quantum dots is to measure the optical absorbance in solution at a concentration where Beer's law is operative and calculate the concentration using an estimated extinction coefficient for the material.	A example of a common technique for estimating the extinction coefficient for quantum dot can be found in this reference (Chem. Mater. 2003, 15, 2854-2860)
SOLUBILITY	Water Solubility	Soluble/miscible in water. These products are sold at a concentration of 2 micromolar which is in the range of 0.125 mg/mL to 2 mg/mL depending on the color.	
	Solubility in Organic Solvent	Not soluble/miscible in organic solvent	
N-OCTANOL-WATER PARTITION COEFFICIENT		We have not measured this parameter.	
STABILITY AND REACTIVITY	Flammability	These nanoparticle products are sold as dilute (2 µM or approximately 0.125 mg to 2 mg/mL) aqueous solutions and are therefore classified with a HMIS flammability rating of 0 (same as water).	
	Explosiveness	These products do not pose an explosion hazard. This conclusion is partially based on thermogravimetric analysis (TGA) of our ITK organic quantum dots. TGA shows that	

		no weight loss occurs until about 300 °C. At around 300 °C the particles lose about 10 - 20 % of their mass. This temperature coincides with the boiling point of the organic ligands used in the synthesis of quantum dots. No other weight loss is observed up to a temperature of 650 °C.	
	Oxidizing Properties	These products are not strong oxidizing agents.	
	Oxidation Reduction Potential	These products are not strong reducing agents.	
	Storage Stability and Reactivity (Container Material)	These products are stable in a variety of container materials including, glass and plastic. The product is packaged and shipped in polypropylene vials.	
	Stability to Thermal, Sunlight, and Metal(s)	These products are stable, meaning that they will work for their intended purpose, to multiple rounds of freezing and thawing and moderately high temperatures (0 °C to 37 °C). These products are stable and will work for their intended purpose with moderate sunlight exposure. Some metals will quench the florescence from these particles. Particularly copper (II) and iron (III).	Reference - Cytometry Part A, 79A: 84 89, 2011

SECTION E: Provide a copy of your Globally Harmonized System (GHS) Safety Data Sheet (SDS), if you have prepared one.

Attached is current SDS/Material Safety Data Sheet (MSDS). See Attachment 1

SECTION F: For each nanomaterial you produce or import, describe the analytical test method(s) that you use, or plan to use, to sample, prepare, and analyze a specific matrix to determine the identity and concentration of each specified nanomaterial. Use a separate page to describe the procedure for each, individual matrix, which must include water, air, soil, sediment, sludge, chemical waste, fish, blood, adipose tissue, and urine. Include the information requested in Section D above.

Life Technologies' *Medical Surveillance and Monitoring Plan* requires a bi-annual monitoring of blood and urine samples as well as an annual physical examination of employees who are involved in manufacturing of quantum dots. No cadmium was detectable from either blood or urine samples, when analyzed with the use of Inductively Coupled Plasma/Mass Spectrometry (ICP-MS) (see <http://www.aruplab.com/guides/ug/tests/0025040.jsp> for detailed information on sampling and analysis methodology).

We have not determined the identity and concentration of Qdot® ITK Streptavidin Conjugate Kit nanocrystals in environmental matrix including air, soil, sediment, sludge, chemical waste, fish, and adipose tissue.

ATTACHMENT 1
MATERIAL SAFETY DATA SHEET
(Sample)



SAFETY DATA SHEET

1. Identification of the substance/mixture and of the company/undertaking

Identification of the substance/preparation

Product code Q10041MPCOMPONENTA
Product name Qdot® 525 ITK™ streptavidin conjugate *2 µM solution*

Company/Undertaking Identification

Life Technologies
5791 VAN ALLEN WAY
PO BOX 6482
CARLSBAD, CA 92008
+1 760 603 7200

INVITROGEN CORPORATION
5250 MAINWAY DRIVE
BURLINGTON, ONT
CANADA L7L 6A4
800/263-6236

24 hour Emergency Response (Transport): 866-536-0631
301-431-8585
Outside of the U.S. +1-301-431-8585

For research use only. Not intended for human or animal diagnostic or therapeutic uses.

Revision Date 29-Nov-2011
Product code Q10041MPCOMPONENTA

Product name Qdot® 525 ITK™ streptavidin conjugate *2 µM solution*

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2. Hazards identification

GHS - Classification

Signal Word
not hazardous

Health Hazard
not hazardous

Physical Hazards
not hazardous

**Principle Routes of Exposure/
Potential Health effects**

Eyes	May cause eye irritation with susceptible persons.
Skin	May cause skin irritation in susceptible persons.
Inhalation	May be harmful by inhalation.
Ingestion	May be harmful if swallowed.

Specific effects

Carcinogenic effects	none.
Mutagenic effects	none.
Reproductive toxicity	none.
Sensitization	none.

Target Organ Effects No known effects under normal use conditions

HMIS

Health	0
Flammability	0
Reactivity	0

3. Composition/information on ingredients

Chemical Name	CAS-No	EINECS-No	Weight %
Sodium azide	26628-22-8	247-852-1	<0.1

The product contains no substances which at their given concentration, are considered to be hazardous to health. We recommend handling all chemicals with caution.

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Product code Q10041MPCOMPONENTA

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Product name Qdot® 525 ITK™ streptavidin conjugate *2 µM solution*

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4. First aid measures

Skin contact	Rinse with plenty of water. If symptoms arise, call a physician.
Eye contact	Rinse immediately with plenty of water, also under the eyelids, for at least 15 minutes. If symptoms persist, call a physician.
Ingestion	Never give anything by mouth to an unconscious person. If symptoms persist, call a physician. Do not induce vomiting without medical advice.
Inhalation	Move to fresh air. If symptoms persist, call a physician. If not breathing, give artificial respiration.
Notes to physician	Treat symptomatically.

5. Fire-fighting measures

Suitable extinguishing media	Water spray. Carbon dioxide (CO ₂). Foam. Dry chemical.
Special protective equipment for firefighters	Wear self-contained breathing apparatus and protective suit.

6. Accidental release measures

Personal precautions	Use personal protective equipment.
Methods for cleaning up	Soak up with inert absorbent material.

Environmental precautions

Prevent further leakage or spillage if safe to do so.

See Section 12 for additional information.

7. Handling and storage

Handling	Always wear recommended Personal Protective Equipment. No special handling advice required.
Storage	Keep in a dry, cool and well-ventilated place.

8. Exposure controls/personal protection

Exposure limits

At this time, the limited evidence available suggests caution when potential exposures to nanoparticles may occur. Due to the limited information about health risks from nanomaterials, it is prudent to take steps for minimizing worker exposures. Research is still needed to understand the impact of nanotechnology on health, and to determine appropriate exposure monitoring and control strategies.

Engineering measures	Ensure adequate ventilation, especially in confined areas.
-----------------------------	--

Personal protective equipment

Respiratory protection	In case of insufficient ventilation wear suitable respiratory equipment.
Hand protection	Impervious gloves.
Eye protection	Safety glasses with side-shields.
Skin and body protection.	Lightweight protective clothing.

Revision Date 29-Nov-2011
Product code Q10041MPCOMPONENTA

Page 3 / 7
Product name Qdot® 525 ITK™ streptavidin conjugate "2 µM solution"

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Hygiene measures Handle in accordance with good industrial hygiene and safety practice.

Environmental exposure controls Prevent product from entering drains.

9. Physical and chemical properties

General Information

Form suspension
Appearance liquid
Odor No information available
Boiling Point/Range °C no data available °F no data available
Melting point/range °C no data available °F no data available
Flash point °C no data available °F no data available
Autoignition temperature °C no data available °F no data available
Oxidizing properties No information available.
Water solubility soluble
pH VALUE 8.3

10. Stability and reactivity

Stability Stable under normal conditions.
Materials to avoid No dangerous reaction known under conditions of normal use.
Hazardous decomposition products None under normal use
polymerization Hazardous polymerisation does not occur.

11. Toxicological information

Acute toxicity

At this time, the limited evidence available suggests caution when potential exposures to nanoparticles may occur. Due to the limited information about health risks from nanomaterials, it is prudent to take steps for minimizing worker exposures. Occupational health risks associated with manufacturing and using nanomaterials are not yet clearly understood. Studies have indicated that low solubility nanoparticles are more toxic than larger particles on a mass for mass basis. There are strong indications that particle surface area and surface chemistry are responsible for observed responses in cell cultures and animals. There are indications that nanoparticles can penetrate through the skin or move from the respiratory system to other organs.

Chemical Name	LD50 (oral,rat/mouse)	LD50 (dermal,rat/rabbit)	LC50 (inhalation,rat/mouse)
Sodium azide	≈ 27 mg/kg (Rat)	no data available	no data available

**Principle Routes of Exposure/
Potential Health effects**

Eyes May cause eye irritation with susceptible persons.
Skin May cause skin irritation in susceptible persons.
Inhalation May be harmful by inhalation.
Ingestion May be harmful if swallowed.

Carcinogenic effects none
Mutagenic effects none

Revision Date 20-Nov-2011 Page 4/7
 Product code Q1004IMPCOMPONENTA Product name Qdot® 525 ITK™ streptavidin conjugate '2 µM solution'

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Reproductive toxicity	none
Sensitization	none
Target Organ Effects	No known effects under normal use conditions

12. Ecological information

Ecotoxicity effects	No information available.
Mobility	No information available.
Biodegradation	Inherently biodegradable
Bioaccumulation	Does not bioaccumulate.

13. Disposal considerations

Dispose of in accordance with local regulations.

14. Transport information

IATA

Proper shipping name	Not classified as dangerous in the meaning of transport regulations
Hazard class	none
Subsidiary Class	none
Packing group	none
UN-No	None

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Product code Q10041MPCOMPONENTA

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Product name Qdot® 525 ITK™ streptavidin conjugate *2 µM solution*

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15. Regulatory information

Component	TSCA
Sodium azide 28628-22-8 (<0.1)	Listed

U.S. Federal Regulations

SARA 313

This product contains the following toxic chemical(s) subject to the notification requirements of section 313 of Title III of the Superfund Amendments and Reauthorization Act of 1986. This law requires certain manufacturers to report on annual emissions of specified chemicals and chemical categories. Please note that if you repackage, or otherwise redistribute, this product to industrial customers, a notice similar to this one should be sent to those customers:

Chemical Name	CAS-No	Weight %	SARA 313 - Threshold Values
Sodium azide	28628-22-8	<0.1	1.0

Clean Air Act, Section 112 Hazardous Air Pollutants (HAPs) (see 40 CFR 61)

This product does not contain HAPs.

U.S. State Regulations

Chemical Name	Massachusetts - RTK	New Jersey - RTK	Pennsylvania - RTK	Illinois - RTK	Rhode Island - RTK
Sodium azide	Listed	Listed	Listed	-	Listed

California Proposition 65

This product does not contain chemicals listed under Proposition 65

WHMIS hazard class:

Non-controlled

This product has been classified according to the hazard criteria of the CPR and the MSDS contains all of the information required by the CPR

16. Other information

Reason for Revision (M)SDS sections updated.

For research use only. Not intended for human or animal diagnostic or therapeutic uses.

References

- National Institute for Occupational Safety and Health (NIOSH), U.S., 2010:
<http://www.cdc.gov/niosh/topics/nanotech/>
- National Institute for Occupational Safety and Health (NIOSH), U.S., 2009:
<http://www.cdc.gov/niosh/docs/2009-125/pdfs/2009-125.pdf>

The above information was acquired by diligent search and/or investigation and the recommendations are based on prudent application of professional judgment. The information shall not be taken as being all inclusive and is to be used only as a guide. All materials and mixtures may present unknown hazards and should be used with caution. Since the Company cannot control the actual methods, volumes, or conditions of use, the Company shall not be held liable for any damages or losses resulting from the handling or from contact with the product as described herein. THE INFORMATION IN THIS MSDS DOES NOT CONSTITUTE A WARRENTY, EXPRESSED OR IMPLIED, INCLUDING ANY IMPLIED WARRANTY OF MERCHANTABILITY OR FITNESS FOR ANY PARTICULAR PUPOSE.

End of Safety Data Sheet

Revision Date 20-Nov-2011
Product code Q10041MPCOMPONENTA

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Product name Qdot® 525 ITK™ streptavidin conjugate '2 µM solution'

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STATE OF CALIFORNIA
Department of Toxic Substances Control

Health and Safety Code Section 57019 Chemical Information Call-in Information
For Nanometals, Nanometal Oxides, and Quantum Dots
December 2010

This enclosure is provided for your convenience. You may provide the requested information in writing, and attaching any supplementary materials or explanatory information, in letter or report form.

SECTION A: CHEMICAL(S) (Check each one which applies for your company)		
<input type="checkbox"/> Nano Silver	<input type="checkbox"/> Nano Titanium Dioxide	<input type="checkbox"/> Nano Cerium Oxide
<input type="checkbox"/> Nano Zero Valent Iron	<input type="checkbox"/> Nano Zinc Oxide	<input checked="" type="checkbox"/> Quantum Dot(s)

SECTION B: BUSINESS IDENTIFICATION INFORMATION (check one and complete 1 – 10)				
<input type="checkbox"/> Sole Owner	<input checked="" type="checkbox"/> Corporation	<input type="checkbox"/> Limited Liability Company (LLC)	<input type="checkbox"/> Limited Liability Partnership (LLP)	<input type="checkbox"/> Unincorporated Business Trust
<input type="checkbox"/> Spouses' Co-ownership	<input type="checkbox"/> Registered Domestic Partnership	<input type="checkbox"/> General Partnership	<input type="checkbox"/> Limited Partnership	<input type="checkbox"/> Other: (describe)
1. Name of Sole Owner, Corporation, Partnership, Institute, Other. Life Technologies Corporation				
2. Business Trade Name ("Doing Business As," if any) None				
3. Business Address (physical location of your business: street number and name, city, state, country, zip or postal code) 5791 Van Allen Way, Carlsbad, California 92008, USA				
4. Mailing Address (street name and number, P.O. box, city, state, country, zip or postal code, if different from 3) The Same as Above				
5. Business Website Address(es): http://www.lifetechnologies.com				
6. Name of Owner, Responsible Corporate Officer, Partner, Other. Sang-Tae Kim				
7. Contact Information for Person in 6 above.				
Name: Sang-Tae Kim		Title: Manager, Design-for-Environment/EHS		
Business Telephone: 650-554-2798		Email: sang-tae.kim@lifetech.com		
8. Number of Employees (California employees). 2908				
9. NAICS Code(s) for this business:		Primary: 325413	Other:	Other:
10. Nano Chemical Business Type: (check applicable)		<input checked="" type="checkbox"/> Manufacturer	<input checked="" type="checkbox"/> Importer	<input checked="" type="checkbox"/> Researcher

SECTION C: CERTIFICATION (FOR THIS COMPLETE SUBMITTAL)		
I am fully authorized to prepare and submit this information, as a formal response to the request pursuant to Health and Safety Code section 57019(d)(1), and certify the information and statements made herein, and in the attachments, are correct to the best of my knowledge and belief.		
Name: (type or print) Sang-Tae Kim	Signature: 	Date: December 15, 2011

SECTION D: NANOMATERIAL CHEMICAL AND PHYSICAL PROPERTIES (Attach additional pages as needed)		
PRODUCT / PRODUCTION INFORMATION		
NANO CHEMICAL NAME: Qdot® ITK™ organic quantum dots		
COMMERCIAL NAME(S): Qdot® 545 ITK™ organic quantum dots; Qdot® 565 ITK™ organic quantum dots; Qdot® 585 ITK™ organic quantum dots; Qdot® 605 ITK™ organic quantum dots; Qdot® 655 ITK™ organic quantum dots; Qdot® 705 ITK™ organic quantum dots; Qdot® 800 ITK™ organic quantum dots		
ANNUAL PRODUCTION VOLUME: Total annual production is 0.158 gram. Quantity shipped to California is 0.010 gram.		
PRODUCTION METHOD(S): Core and core-shell nanoparticles are produced using common colloidal synthesis techniques. Some examples may be found in the following patents: 6,322,901; 6,815,064; 7,147,712; 7,695,642. Some examples of methods for applying the amphiphilic coating to these particles to render them water soluble may be found in the following patent 6,649,138.		
IDENTIFICATION OF THE SUPPLIER(S): Life Technologies is the producer and supplier of these products.		
PARAMETER	VALUE / RANGE	NAME OF ANALYTICAL METHOD(S)
PHYSICAL PROPERTIES		
SHAPE (MORPHOLOGY)	The morphology of a nanoparticle is most commonly measured by transmission electron microscopy (TEM) since it is the only analytical technique with resolution sufficient to resolve the fine features of a nanoparticle. This technique is limited, however, since it is most sensitive to electron dense elements of the nanoparticle like cadmium, zinc and selenium and virtually insensitive to lighter elements like carbon, hydrogen, oxygen and nitrogen. This means that shape and morphology information is not available for nanoparticles that comprise organic coatings. In other words, TEM can only give you information about the nanocrystal within a nanoparticle. TEM is further limited by the fact that the data acquired is only a two dimensional projection of the three dimensional shape. Therefore to calculate the volume or surface area, a three dimensional shape must be assumed. The size of the nanoparticle (nanocrystal and organic ligands) can be measured by size exclusion chromatography (SEC) but this technique does not have the resolution to provide morphology information.	
DENSITY	The density of these materials has not been measured	
SURFACE AREA	Since we cannot measure the three dimensional morphology of Qdot® ITK™ organic quantum dot nanoparticles, we cannot calculate the surface area. If we assume a geometric shape to approximate the morphology, we can use geometry to approximate a surface area.	
PARTICLE SIZE DISTRIBUTION	Air	To the best of our knowledge, no technique is currently available
	Liquid	Dynamic light scattering can give particle size distribution data, however, several complications exist in interpreting the data. Some of those caveats include, (1) since quantum dots have broad absorbance, any color that emits at longer wavelengths than the laser will absorb some of the laser light and make interpretation of the data nearly impossible, (2) large particles scatter much more efficiently than smaller particles making detection of small particle populations difficult.
	Solid/ Powder	To the best of our knowledge, no technique is currently available
OTHER (SPECIFY)		
CHEMICAL PROPERTIES		
CHEMICAL COMPOSITION	The inorganic portion of the nanoparticles (nanocrystal) is composed of cadmium, selenium, zinc and sulfur. Two of	

		our nanocrystal products (Qdot 705 and 800) additionally contain tellurium. The exact composition of the ligand shell is unknown but NMR has revealed that it is mostly composed of tetradecylphosphonic acid (TDPA) and/or other phosphorus-containing species. These products are packaged as solutions in decane.	
SURFACE MODIFICATION (COATING, FUNCTIONALIZATION)		The outer surface contains an aliphatic hydrocarbon like tetradecylphosphonic acid. Oxygen atoms on the phosphonic acid are covalently attached to the quantum dot surface and the hydrocarbon tails are directed outward.	
PURITY		These products are sold as-is in terms of chemical purity. Spectral purity is all that we measure.	
SURFACE CHARGE		We do not measure surface charge for these products	
DISPERSION	Air	We do not handle air dispersions in our operations or R&D	
	Liquid	We do not measure the size dispersion for these products directly. We rely on the size dependent nature of the optical properties to give us an indication of particle dispersion. For example, narrow emission width would correlate to narrow particle size distribution.	
	Solid	We do not handle the materials in the solid form, but as a liquid dispersion.	
IDENTIFYING AND DETERMINING CONCENTRATION OF NANO CHEMICAL, ITS METABOLITES, AND DEGRADATION PRODUCTS IN SPECIFIED MATRICES (Water, Air, Soil, Sediment, Sludge, Chemical Waste, Fish, Blood, Adipose Tissue, Urine, Other)		Determining the exact concentration of nanoparticles in any matrix is difficult because routine nanoparticle counting techniques do not currently exist. The most common method for determining the concentration of quantum dots is to measure the optical absorbance in solution at a concentration where Beer's law is operative and calculate the concentration using an estimated extinction coefficient for the material.	A example of a common technique for estimating the extinction coefficient for quantum dot can be found in this reference (Chem. Mater. 2003, 15, 2854-2860)
SOLUBILITY	Water Solubility	Not soluble/miscible in water.	
	Solubility in Organic Solvent	Soluble/miscible in non-polar solvents like decane, hexane, toluene, and chloroform. These products are sold at a concentration of 8 micromolar which is in the range of 0.5 mg/mL to 8 mg/mL depending on the color.	
N-OCTANOL-WATER PARTITION COEFFICIENT		We have not measured this parameter.	
STABILITY AND REACTIVITY	Flammability	These nanoparticle products are sold as dilute (8 µM or approximately 0.5 mg to 8 mg/mL) aqueous solutions and are therefore classified with a HMIS flammability rating of 0 (same as water).	
	Explosiveness	These products do not pose an explosion hazard. This conclusion is partially based on thermogravimetric analysis (TGA) of our ITK organic quantum dots. TGA shows that no weight loss occurs until about 300 °C. At around 300 °C the particles lose about 10 - 20 % of their mass. This temperature coincides with the boiling point of the organic ligands used in the synthesis of quantum dots. No other weight loss is observed up to a temperature of 650 °C.	
	Oxidizing Properties	These products are not strong oxidizing agents.	
	Oxidation Reduction Potential	These products are not strong reducing agents.	
	Storage Stability and Reactivity (Container)	These products are stable in a variety of container materials including, glass and plastic. The product is packaged and shipped in polypropylene vials.	

	Material)		
	Stability to Thermal, Sunlight, and Metal(s)	These products are stable, meaning that they will work for their intended purpose, to multiple rounds of freezing and thawing and moderately high temperatures (0 °C to 37 °C). These products are stable and will work for their intended purpose with moderate sunlight exposure. Some metals will quench the florescence from these particles. Particularly copper (II) and iron (III).	Reference - Cytometry Part A, 79A: 84 89, 2011

SECTION E: Provide a copy of your Globally Harmonized System (GHS) Safety Data Sheet (SDS), if you have prepared one.

Attached is current SDS/Material Safety Data Sheet (MSDS). See Attachment 1

SECTION F: For each nanomaterial you produce or import, describe the analytical test method(s) that you use, or plan to use, to sample, prepare, and analyze a specific matrix to determine the identity and concentration of each specified nanomaterial. Use a separate page to describe the procedure for each, individual matrix, which must include water, air, soil, sediment, sludge, chemical waste, fish, blood, adipose tissue, and urine. Include the information requested in Section D above.

Life Technologies' *Medical Surveillance and Monitoring Plan* requires a bi-annual monitoring of blood and urine samples as well as an annual physical examination of employees who are involved in manufacturing of quantum dots. No cadmium was detectable from either blood or urine samples, when analyzed with the use of Inductively Coupled Plasma/Mass Spectrometry (ICP-MS) (see <http://www.aruplab.com/guides/ug/tests/0025040.jsp> for detailed information on sampling and analysis methodology).

We have not determined the identity and concentration of Qdot® ITK™ organic quantum dot nanocrystals in environmental matrix including air, soil, sediment, sludge, chemical waste, fish, and adipose tissue.

ATTACHMENT 1
MATERIAL SAFETY DATA SHEET
(Sample)



SAFETY DATA SHEET

1. Identification of the substance/mixture and of the company/undertaking

Identification of the substance/preparation

Product code Q21791MP
Product name Qdot® 545 ITK™ organic quantum dots

Company/Undertaking Identification

Life Technologies
5791 VAN ALLEN WAY
PO BOX 6482
CARLSBAD, CA 92008
+1 760 603 7200

INVITROGEN CORPORATION
5250 MAINWAY DRIVE
BURLINGTON, ONT
CANADA L7L 6A4
800/283-6236

24 hour Emergency Response (Transport): 866-536-0631
301-431-8585
Outside of the U.S. +1-301-431-8585

For research use only. Not intended for human or animal diagnostic or therapeutic uses.

Revision Date 30-Nov-2011
Product code Q21791MP

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Product name Qdot® 545 ITK™ organic quantum dots

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2. Hazards identification

GHS - Classification

Signal Word
WARNING



Health Hazard

Acute dermal toxicity	Category 5
-----------------------	------------

Physical Hazards

GHS Physical Hazard 1	Flammable liquids
GHS Physical Hazard Category Number	Category 3

Physical hazards

H226 - Flammable liquid and vapor

Hazard statements

H313 - May be harmful in contact with skin

H410 - Very toxic to aquatic life with long lasting effects

Revision Date 30-Nov-2011
Product code Q21701MP

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Product name Qdot® 545 ITK™ organic quantum dots

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Precautionary statements

- P312 - Call a POISON CENTER or doctor/physician if you feel unwell
- P303 + P361 + P353 - IF ON SKIN (or hair): Take off immediately all contaminated clothing. Rinse skin with water/shower
- P403 + P233 - Store in a well-ventilated place. Keep container tightly closed
- P241 - Use explosion-proof electrical/ventilating/lighting/equipment
- P242 - Use only non-sparking tools
- P243 - Take precautionary measures against static discharge
- P280 - Wear protective gloves/protective clothing/eye protection/face protection
- P391 - Collect spillage
- P273 - Avoid release to the environment

Principle Routes of Exposure/

Potential Health effects

- Eyes** May cause eye irritation with susceptible persons.
- Skin** May be harmful in contact with skin.
- Inhalation** May cause irritation of respiratory tract.
- Ingestion** May be harmful if swallowed.

Specific effects

- Carcinogenic effects** none
- Mutagenic effects** none
- Reproductive toxicity** none
- Sensitization** none

Target Organ Effects No known effects under normal use conditions.

HMS

Health	1
Flammability	3
Reactivity	0

3. Composition/information on ingredients

Chemical Name	CAS-No	EINECS-No	Weight %
Decane	124-18-5	204-686-4	60-100

We recommend handling all chemicals with caution.

4. First aid measures

- Skin contact** Wash off immediately with plenty of water. Remove and wash contaminated clothing before re-use. Consult a physician.
- Eye contact** Rinse immediately with plenty of water, also under the eyelids, for at least 15 minutes. Consult a physician.
- Ingestion** Never give anything by mouth to an unconscious person. Call a POISON CENTER or doctor/physician if exposed or you feel unwell.
- Inhalation** Move to fresh air. If not breathing, give artificial respiration. Consult a physician.
- Notes to physician** Treat symptomatically.

5. Fire-fighting measures

Revision Date 30-Nov-2011
 Product code Q21791MP

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 Product name Qdot® 545 ITK™ organic quantum dots

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Suitable extinguishing media	Foam. Dry chemical. Carbon dioxide (CO2). Water spray or fog.
Special protective equipment for firefighters	Wear self-contained breathing apparatus and protective suit.

Australia HazChem Code 3Y

6. Accidental release measures

Personal precautions	Use personal protective equipment. Avoid contact with skin, eyes and clothing. Remove all sources of ignition.
Methods for cleaning up	Soak up with inert absorbent material. Pick up and transfer to properly labelled containers. Ground and bond containers when transferring material.

Environmental precautions

Prevent further leakage or spillage if safe to do so. Prevent product from entering drains. Prevent entry into waterways, sewers, basements or confined areas.

See Section 12 for additional information.

7. Handling and storage

Handling	Always wear recommended Personal Protective Equipment. Avoid contact with skin and eyes. Remove all sources of ignition.
Storage	Keep in properly labelled containers. Keep in a dry, cool and well-ventilated place. Keep away from open flames, hot surfaces and sources of ignition.

8. Exposure controls/personal protection

Exposure limits

At this time, the limited evidence available suggests caution when potential exposures to nanoparticles may occur. Due to the limited information about health risks from nanomaterials, it is prudent to take steps for minimizing worker exposures. Research is still needed to understand the impact of nanotechnology on health, and to determine appropriate exposure monitoring and control strategies.

Engineering measures	Ensure adequate ventilation, especially in confined areas.
-----------------------------	--

Personal protective equipment

Respiratory protection	In case of insufficient ventilation wear suitable respiratory equipment.
Hand protection	Impervious gloves.
Eye protection	Safety glasses with side-shields.
Skin and body protection.	Lightweight protective clothing.
Hygiene measures	Handle in accordance with good industrial hygiene and safety practice.

Environmental exposure controls	Prevent product from entering drains.
--	---------------------------------------

9. Physical and chemical properties

General Information

Revision Date	30-Nov-2011
Product code	Q217Q1MP

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Product name Qdot® 545 ITK™ organic quantum dots

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Form	suspension	
Appearance	colorless	
Odor	No information available	
Boiling Point/Range	°C 274	°F 525
Melting point/range	°C no data available	°F no data available
Flash point	°C no data available	°F no data available
Autoignition temperature	°C 208	°F 406
Oxidizing properties	No information available.	
Water solubility	slightly soluble	

10. Stability and reactivity

Stability	Stable.
Materials to avoid	Heat
Hazardous decomposition products	No information available.
polymerization	Hazardous polymerisation does not occur.

11. Toxicological information

Acute toxicity

At this time, the limited evidence available suggests caution when potential exposures to nanoparticles may occur. Due to the limited information about health risks from nanomaterials, it is prudent to take steps for minimizing worker exposures. Occupational health risks associated with manufacturing and using nanomaterials are not yet clearly understood. Studies have indicated that low solubility nanoparticles are more toxic than larger particles on a mass for mass basis. There are strong indications that particle surface area and surface chemistry are responsible for observed responses in cell cultures and animals. There are indications that nanoparticles can penetrate through the skin or move from the respiratory system to other organs.

Chemical Name	LD50 (oral, rat/mouse)	LD50 (dermal, rat/rabbit)	LC50 (inhalation, rat/mouse)
Decane	> 5000 mg/kg (Rat)	no data available	=72300mg/m ³ (Mouse)

Principle Routes of Exposure/

Potential Health effects

Eyes	May cause eye irritation with susceptible persons.
Skin	May be harmful in contact with skin.
Inhalation	May cause irritation of respiratory tract.
Ingestion	May be harmful if swallowed.
Carcinogenic effects	none
Mutagenic effects	none
Reproductive toxicity	none
Sensitization	none

12. Ecological information

Ecotoxicity effects	Chlorella vulgaris (Fresh water algae) Daphnia magna (Water flea)
Mobility	see log Pow

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 Product code Q2179iMP

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 Product name Qdot® 545 ITK™ organic quantum dots

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Biodegradation Inherently biodegradable
 Bioaccumulation Does not bioaccumulate.

Chemical Name	Freshwater Algae Data	Water Flea Data	Freshwater Fish Species Data	Microtox Data	log Pow
Decane 124-18-5	Chlorella vulgaris EC50=0.043 mg/L (24 h)	Daphnia magna EC50=0.028 mg/L (48 h)			logPow5.1

13. Disposal considerations

Dispose of in accordance with local regulations
 S61 - Avoid release to the environment. Refer to special instructions/safety data sheets

14. Transport information

IATA
 Proper shipping name n-Decane
 Hazard class 3
 Subsidiary Class none
 Packing group III
 UN-No UN2247

15. Regulatory information

Component	TSCA
Decane 124-18-5 (60-100)	Listed

U.S. Federal Regulations

SARA 313
 This product is not regulated by SARA.

Clean Air Act, Section 112 Hazardous Air Pollutants (HAPs) (see 40 CFR 61)
 This product does not contain HAPs.

U.S. State Regulations

Chemical Name	Massachusetts - RTK	New Jersey - RTK	Pennsylvania - RTK	Illinois - RTK	Rhode Island - RTK
Decane	-	Listed	Listed	-	Listed

California Proposition 65
 This product does not contain chemicals listed under Proposition 65

WHMIS hazard class:
 B3 Combustible liquid
 D2B Toxic materials



This product has been classified according to the hazard criteria of the CPR and the MSDS contains all of the information required by the CPR

Revision Date 30-Nov-2011
 Product code Q21791MP

Page 6/7
 Product name Qdot® 545 ITK™ organic quantum dots

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16. Other information

Reason for Revision not applicable. (M)SDS sections updated.

For research use only.

References

- National Institute for Occupational Safety and Health (NIOSH), U.S., 2010:
<http://www.cdc.gov/niosh/topics/nanotech/>
- National Institute for Occupational Safety and Health (NIOSH), U.S., 2009:
<http://www.cdc.gov/niosh/docs/2009-125/pdfs/2009-125.pdf>

The above information was acquired by diligent search and/or investigation and the recommendations are based on prudent application of professional judgment. The information shall not be taken as being all inclusive and is to be used only as a guide. All materials and mixtures may present unknown hazards and should be used with caution. Since the Company cannot control the actual methods, volumes, or conditions of use, the Company shall not be held liable for any damages or losses resulting from the handling or from contact with the product as described herein. THE INFORMATION IN THIS MSDS DOES NOT CONSTITUTE A WARRANTY, EXPRESSED OR IMPLIED, INCLUDING ANY IMPLIED WARRANTY OF MERCHANTABILITY OR FITNESS FOR ANY PARTICULAR PURPOSE.

End of Safety Data Sheet

Revision Date 30-Nov-2011
Product code Q21791MP

Page 7/7
Product name Qdot® 545 ITK™ organic quantum dots

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STATE OF CALIFORNIA
Department of Toxic Substances Control

Health and Safety Code Section 57019 Chemical Information Call-in Information
For Nanometals, Nanometal Oxides, and Quantum Dots
December 2010

This enclosure is provided for your convenience. You may provide the requested information in writing, and attaching any supplementary materials or explanatory information, in letter or report form.

SECTION A: CHEMICAL(S) (Check each one which applies for your company)		
<input type="checkbox"/> Nano Silver	<input type="checkbox"/> Nano Titanium Dioxide	<input type="checkbox"/> Nano Cerium Oxide
<input type="checkbox"/> Nano Zero Valent Iron	<input type="checkbox"/> Nano Zinc Oxide	<input checked="" type="checkbox"/> Quantum Dot(s)

SECTION B: BUSINESS IDENTIFICATION INFORMATION (check one and complete 1 – 10)				
<input type="checkbox"/> Sole Owner	<input checked="" type="checkbox"/> Corporation	<input type="checkbox"/> Limited Liability Company (LLC)	<input type="checkbox"/> Limited Liability Partnership (LLP)	<input type="checkbox"/> Unincorporated Business Trust
<input type="checkbox"/> Spouses' Co-ownership	<input type="checkbox"/> Registered Domestic Partnership	<input type="checkbox"/> General Partnership	<input type="checkbox"/> Limited Partnership	<input type="checkbox"/> Other: (describe)
1. Name of Sole Owner, Corporation, Partnership, Institute, Other. Life Technologies Corporation				
2. Business Trade Name ("Doing Business As," if any) None				
3. Business Address (physical location of your business: street number and name, city, state, country, zip or postal code) 5791 Van Allen Way, Carlsbad, California 92008, USA				
4. Mailing Address (street name and number, P.O. box, city, state, country, zip or postal code, if different from 3) The Same as Above				
5. Business Website Address(es): http://www.lifetechnologies.com				
6. Name of Owner, Responsible Corporate Officer, Partner, Other. Sang-Tae Kim				
7. Contact Information for Person in 6 above.				
Name: Sang-Tae Kim		Title: Manager, Design-for-Environment/EHS		
Business Telephone: 650-554-2798		Email: sang-tae.kim@lifetech.com		
8. Number of Employees (California employees). 2908				
9. NAICS Code(s) for this business:		Primary: 325413	Other:	Other:
10. Nano Chemical Business Type: (check applicable)		<input checked="" type="checkbox"/> Manufacturer	<input checked="" type="checkbox"/> Importer	<input checked="" type="checkbox"/> Researcher

SECTION C: CERTIFICATION (FOR THIS COMPLETE SUBMITTAL)		
I am fully authorized to prepare and submit this information, as a formal response to the request pursuant to Health and Safety Code section 57019(d)(1), and certify the information and statements made herein, and in the attachments, are correct to the best of my knowledge and belief.		
Name: (type or print) Sang-Tae Kim	Signature: 	Date: December 15, 2011

SECTION D: NANOMATERIAL CHEMICAL AND PHYSICAL PROPERTIES (Attach additional pages as needed)		
PRODUCT / PRODUCTION INFORMATION		
NANO CHEMICAL NAME: Qdot® Antibody Conjugation Kit		
COMMERCIAL NAME(S): Qdot® 525 Antibody Conjugation Kit; Qdot® 565 Antibody Conjugation Kit; Qdot® 585 Antibody Conjugation Kit; Qdot® 605 Antibody Conjugation Kit; Qdot® 625 Antibody Conjugation Kit; Qdot® 655 Antibody Conjugation Kit; Qdot® 705 Antibody Conjugation Kit; Qdot® 800 Antibody Conjugation Kit		
ANNUAL PRODUCTION VOLUME: Total annual production is 0.595 gram. Quantity shipped to California is 0.041 gram.		
PRODUCTION METHOD(S): Core and core-shell nanoparticles are produced using common colloidal synthesis techniques. Some examples may be found in the following patents: 6,322,901; 6,815,064; 7,147,712; 7,695,642. Some examples of methods for applying the amphiphilic coating to these particles to render them water soluble may be found in the following patent 6,649,138.		
IDENTIFICATION OF THE SUPPLIER(S): Life Technologies is the producer and supplier of these products.		
PARAMETER	VALUE / RANGE	NAME OF ANALYTICAL METHOD(S)
PHYSICAL PROPERTIES		
SHAPE (MORPHOLOGY)	The morphology of a nanoparticle is most commonly measured by transmission electron microscopy (TEM) since it is the only analytical technique with resolution sufficient to resolve the fine features of a nanoparticle. This technique is limited, however, since it is most sensitive to electron dense elements of the nanoparticle like cadmium, zinc and selenium and virtually insensitive to lighter elements like carbon, hydrogen, oxygen and nitrogen. This means that shape and morphology information is not available for nanoparticles that comprise organic coatings. In other words, TEM can only give you information about the nanocrystal within a nanoparticle. TEM is further limited by the fact that the data acquired is only a two dimensional projection of the three dimensional shape. Therefore to calculate the volume or surface area, a three dimensional shape must be assumed. The size of the nanoparticle (nanocrystal and organic ligands) can be measured by size exclusion chromatography (SEC) but this technique does not have the resolution to provide morphology information.	
DENSITY	The density of these materials has not been measured	
SURFACE AREA	Since we cannot measure the morphology of Qdot® Antibody Conjugation Kit nanoparticles, we cannot calculate the surface area. If we approximate the morphology as a sphere and use the SEC sizing data, we can calculate a spherical surface area.	
PARTICLE SIZE DISTRIBUTION	Air	To the best of our knowledge, no technique is currently available
	Liquid	Dynamic light scattering can give particle size distribution data, however, several complications exist in interpreting the data. Some of those caveats include, (1) since quantum dots have broad absorbance, any color that emits at longer wavelengths than the laser will absorb some of the laser light and make interpretation of the data nearly impossible, (2) large particles scatter much more efficiently than smaller particles making detection of small particle populations difficult.
	Solid/Powder	To the best of our knowledge, no technique is currently available
OTHER (SPECIFY)		
CHEMICAL PROPERTIES		
CHEMICAL COMPOSITION	The inorganic portion of the nanoparticles (nanocrystal) is	The chemical

		composed of cadmium, selenium, zinc and sulfur. Two of our nanocrystal products (Qdot 705 and 800) additionally contain tellurium. The exact composition of the ligand shell is unknown but NMR has revealed that it is mostly composed of tetradecylphosphonic acid (TDPA) and/or other phosphorus-containing species. The polymer coating is an amphiphilic molecule that is associated with the nanoparticle and provides water solubility. The polyethylene glycol (PEG) coating is attached to the polymer coating through amide bonds created by reacting amine-functional PEG molecules with carbodiimide (e.g., 1-Ethyl-3-[3-dimethylaminopropyl]carbodiimide hydrochloride) activated carboxylate groups on the polymer coating.	composition of this polymer is best described in Patent Number 6,649,138
SURFACE MODIFICATION (COATING, FUNCTIONALIZATION)		The outer surface contains an amphiphilic polymer and PEG molecules.	The process of applying this polymer to the nanoparticles is best described in patent number 6,649,138.
PURITY		Purity is essential for our products. We have most routinely use SEC to detect and measure impurities. Some of those impurities include aggregated nanoparticles, free (unbound) amphiphilic polymer, and other nanoparticle impurities.	
SURFACE CHARGE		We routinely perform gel electrophoresis to confirm the charge of a particle but we do not quantitate it in terms of charge density.	
DISPERSION	Air	We do not handle air dispersions in our operations or R&D	
	Liquid	Presence of aggregated particles is routinely measured by SEC chromatography. In fact, all of our products and water soluble intermediates have specifications around the percentage of these soluble aggregates present in the solution.	
	Solid	We do not handle the materials in the solid form, but as a liquid dispersion.	
IDENTIFYING AND DETERMINING CONCENTRATION OF NANO CHEMICAL, ITS METABOLITES, AND DEGRADATION PRODUCTS IN SPECIFIED MATRICES (Water, Air, Soil, Sediment, Sludge, Chemical Waste, Fish, Blood, Adipose Tissue, Urine, Other)		Determining the exact concentration of nanoparticles in any matrix is difficult because routine nanoparticle counting techniques do not currently exist. The most common method for determining the concentration of quantum dots is to measure the optical absorbance in solution at a concentration where Beer's law is operative and calculate the concentration using an estimated extinction coefficient for the material.	A example of a common technique for estimating the extinction coefficient for quantum dot can be found in this reference (Chem. Mater. 2003, 15, 2854-2860)
SOLUBILITY	Water Solubility	Soluble/miscible in water. These products are sold at a concentration of 4 micromolar which is in the range of 0.25 mg/mL to 4 mg/mL depending on the color.	
	Solubility in Organic Solvent	Not soluble/miscible in organic solvent	
N-OCTANOL-WATER PARTITION COEFFICIENT		We have not measured this parameter.	
STABILITY AND REACTIVITY	Flammability	These nanoparticle products are sold as dilute (4 µM or approximately 0.25 mg to 4 mg/mL) aqueous solutions and are therefore classified with a HMIS flammability rating of 0 (same as water).	
	Explosiveness	These products do not pose an explosion hazard. This conclusion is partially based on thermogravimetric analysis	

Qdot® Antibody Conjugation Kit

		(TGA) of our ITK organic quantum dots. TGA shows that no weight loss occurs until about 300 °C. At around 300 °C the particles lose about 10 - 20 % of their mass. This temperature coincides with the boiling point of the organic ligands used in the synthesis of quantum dots. No other weight loss is observed up to a temperature of 650 °C.	
	Oxidizing Properties	These products are not strong oxidizing agents.	
	Oxidation Reduction Potential	These products are not strong reducing agents.	
	Storage Stability and Reactivity (Container Material)	These products are stable in a variety of container materials including, glass and plastic. The product is packaged and shipped in polypropylene vials.	
	Stability to Thermal, Sunlight, and Metal(s)	These products are stable, meaning that they will work for their intended purpose, to multiple rounds of freezing and thawing and moderately high temperatures (0 °C to 37 °C). These products are stable and will work for their intended purpose with moderate sunlight exposure. Some metals will quench the fluorescence from these particles. Particularly copper (II) and iron (III).	Reference - Cytometry Part A, 79A: 84 89, 2011

SECTION E: Provide a copy of your Globally Harmonized System (GHS) Safety Data Sheet (SDS), if you have prepared one.

Attached is current SDS/Material Safety Data Sheet (MSDS). See Attachment 1

SECTION F: For each nanomaterial you produce or import, describe the analytical test method(s) that you use, or plan to use, to sample, prepare, and analyze a specific matrix to determine the identity and concentration of each specified nanomaterial. Use a separate page to describe the procedure for each, individual matrix, which must include water, air, soil, sediment, sludge, chemical waste, fish, blood, adipose tissue, and urine. Include the information requested in Section D above.

Life Technologies' *Medical Surveillance and Monitoring Plan* requires a bi-annual monitoring of blood and urine samples as well as an annual physical examination of employees who are involved in manufacturing of quantum dots. No cadmium was detectable from either blood or urine samples, when analyzed with the use of Inductively Coupled Plasma/Mass Spectrometry (ICP-MS) (see <http://www.aruplab.com/guides/ug/tests/0025040.jsp> for detailed information on sampling and analysis methodology).

We have not determined the identity and concentration of Qdot® Antibody Conjugation Kit nanocrystals in environmental matrix including air, soil, sediment, sludge, chemical waste, fish, and adipose tissue.

ATTACHMENT 1
MATERIAL SAFETY DATA SHEET
(Sample)



SAFETY DATA SHEET

1. Identification of the substance/mixture and of the company/undertaking

Identification of the substance/preparation

Product code Q22041MPA
Product name Qdot® 525 nanocrystals, amine functionalized *4 µM solution*

Company/Undertaking Identification

Life Technologies
5791 VAN ALLEN WAY
PO BOX 6482
CARLSBAD, CA 92008
+1 760 603 7200

INVITROGEN CORPORATION
5250 MAINWAY DRIVE
BURLINGTON, ONT
CANADA L7L 6A4
800/263-6236

24 hour Emergency Response (Transport): 866-536-0631
301-431-8585
Outside of the U.S. +1-301-431-8585

For research use only. Not intended for human or animal diagnostic or therapeutic uses.

Revision Date 29-Nov-2011
Product code Q22041MPA

Product name Qdot® 525 nanocrystals, amine functionalized *4 µM solution*
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2. Hazards identification

GHS - Classification

Signal Word
not hazardous

Health Hazard
not hazardous

Physical Hazards
not hazardous

Principle Routes of Exposure/

Potential Health effects

Eyes	May cause eye irritation with susceptible persons.
Skin	May cause skin irritation in susceptible persons.
Inhalation	May be harmful by inhalation.
Ingestion	May be harmful if swallowed.

Specific effects

Carcinogenic effects	none.
Mutagenic effects	none.
Reproductive toxicity	none.
Sensitization	none.

Target Organ Effects No known effects under normal use conditions

HMIS

Health	0
Flammability	0
Reactivity	0

3. Composition/information on ingredients

The product contains no substances which at their given concentration, are considered to be hazardous to health. We recommend handling all chemicals with caution.

4. First aid measures

Revision Date 20-Nov-2011
Product code Q22041MPA

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Product name Qdot® 525 nanocrystals, amine functionalized "4 µM solution"

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Skin contact	Rinse with plenty of water. If symptoms arise, call a physician.
Eye contact	Rinse immediately with plenty of water, also under the eyelids, for at least 15 minutes. If symptoms persist, call a physician.
Ingestion	Never give anything by mouth to an unconscious person. If symptoms persist, call a physician. Do not induce vomiting without medical advice.
Inhalation	Move to fresh air. If symptoms persist, call a physician. If not breathing, give artificial respiration.
Notes to physician	Treat symptomatically.

5. Fire-fighting measures

Suitable extinguishing media	Water spray. Carbon dioxide (CO ₂). Foam. Dry chemical.
Special protective equipment for firefighters	Wear self-contained breathing apparatus and protective suit.

6. Accidental release measures

Personal precautions	Use personal protective equipment.
Methods for cleaning up	Soak up with inert absorbent material.

Environmental precautions

Prevent further leakage or spillage if safe to do so.

See Section 12 for additional information.

7. Handling and storage

Handling	Always wear recommended Personal Protective Equipment. No special handling advice required.
Storage	Keep in a dry, cool and well-ventilated place.

8. Exposure controls/personal protection

Exposure limits

At this time, the limited evidence available suggests caution when potential exposures to nanoparticles may occur. Due to the limited information about health risks from nanomaterials, it is prudent to take steps for minimizing worker exposures. Research is still needed to understand the impact of nanotechnology on health, and to determine appropriate exposure monitoring and control strategies.

Engineering measures Ensure adequate ventilation, especially in confined areas.

Personal protective equipment

Respiratory protection	In case of insufficient ventilation wear suitable respiratory equipment.
Hand protection	Impervious gloves.
Eye protection	Safety glasses with side-shields.
Skin and body protection.	Lightweight protective clothing.
Hygiene measures	Handle in accordance with good industrial hygiene and safety practice.

Revision Date 29-Nov-2011
Product code Q22041MPA

Product name Qdot® 525 nanocrystals, amine functionalized '4 µM solution'
Page 3 / 8
solution'

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Environmental exposure controls Prevent product from entering drains.

9. Physical and chemical properties

General Information

Form	suspension	
Appearance	liquid	
Odor	No information available	
Boiling Point/Range	°C no data available	°F no data available
Melting point/range	°C no data available	°F no data available
Flash point	°C no data available	°F no data available
Autoignition temperature	°C no data available	°F no data available
Oxidizing properties	No information available.	
Water solubility	soluble	

10. Stability and reactivity

Stability	Stable under normal conditions.
Materials to avoid	No dangerous reaction known under conditions of normal use.
Hazardous decomposition products	None under normal use
polymerization	Hazardous polymerisation does not occur.

11. Toxicological information

Acute toxicity

At this time, the limited evidence available suggests caution when potential exposures to nanoparticles may occur. Due to the limited information about health risks from nanomaterials, it is prudent to take steps for minimizing worker exposures. Occupational health risks associated with manufacturing and using nanomaterials are not yet clearly understood. Studies have indicated that low solubility nanoparticles are more toxic than larger particles on a mass for mass basis. There are strong indications that particle surface area and surface chemistry are responsible for observed responses in cell cultures and animals. There are indications that nanoparticles can penetrate through the skin or move from the respiratory system to other organs.

**Principle Routes of Exposure/
Potential Health effects**

Eyes	May cause eye irritation with susceptible persons.
Skin	May cause skin irritation in susceptible persons.
Inhalation	May be harmful by inhalation.
Ingestion	May be harmful if swallowed.
Carcinogenic effects	none
Mutagenic effects	none
Reproductive toxicity	none
Sensitization	none

Revision Date 29-Nov-2011
Product code Q22041MPA

Page 4 / 6
Product name Qdot® 525 nanocrystals, amine functionalized *4 µM solution*

Target Organ Effects No known effects under normal use conditions

12. Ecological information

Ecotoxicity effects	No information available.
Mobility	No information available.
Biodegradation	Inherently biodegradable
Bioaccumulation	Does not bioaccumulate.

13. Disposal considerations

Dispose of in accordance with local regulations.

14. Transport information

<u>IATA</u>	
Proper shipping name	Not classified as dangerous in the meaning of transport regulations
Hazard class	none
Subsidiary Class	none
Packing group	none
UN-No	None

15. Regulatory information

U.S. Federal Regulations

SARA 313

This product contains the following toxic chemical(s) subject to the notification requirements of section 313 of Title III of the Superfund Amendments and Reauthorization Act of 1980. This law requires certain manufacturers to report on annual emissions of specified chemicals and chemical categories. Please note that if you repackage, or otherwise redistribute, this product to industrial customers, a notice similar to this one should be sent to those customers:

Clean Air Act, Section 112 Hazardous Air Pollutants (HAPs) (see 40 CFR 61)

This product does not contain HAPs.

U.S. State Regulations

California Proposition 65

This product does not contain chemicals listed under Proposition 65

WHMIS hazard class:

Non-controlled

This product has been classified according to the hazard criteria of the CPR and the MSDS contains all of the information required by the CPR

16. Other information

Revision Date 29-Nov-2011
Product code Q22041MPA

Page 5 / 6
Product name Qdot® 525 nanocrystals, amine functionalized *4 µM solution*

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Reason for Revision (M)SDS sections updated.

For research use only. Not intended for human or animal diagnostic or therapeutic uses.

References

- National Institute for Occupational Safety and Health (NIOSH), U.S., 2010:
<http://www.cdc.gov/niosh/topics/nanotech/>
- National Institute for Occupational Safety and Health (NIOSH), U.S., 2009:
<http://www.cdc.gov/niosh/docs/2009-125/pdfs/2009-125.pdf>

The above information was acquired by diligent search and/or investigation and the recommendations are based on prudent application of professional judgment. The information shall not be taken as being all inclusive and is to be used only as a guide. All materials and mixtures may present unknown hazards and should be used with caution. Since the Company cannot control the actual methods, volumes, or conditions of use, the Company shall not be held liable for any damages or losses resulting from the handling or from contact with the product as described herein. THE INFORMATION IN THIS MSDS DOES NOT CONSTITUTE A WARRANTY, EXPRESSED OR IMPLIED, INCLUDING ANY IMPLIED WARRANTY OF MERCHANTABILITY OR FITNESS FOR ANY PARTICULAR PUPOSE.

End of Safety Data Sheet

Revision Date 20-Nov-2011
Product code Q22041MPA

Page 6 / 8
Product name Qdot® 525 nanocrystals, amine functionalized *4 µM solution*

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**STATE OF CALIFORNIA
Department of Toxic Substances Control**

**Health and Safety Code Section 57019 Chemical Information Call-in Information
For Nanometals, Nanometal Oxides, and Quantum Dots
December 2010**

This enclosure is provided for your convenience. You may provide the requested information in writing, and attaching any supplementary materials or explanatory information, in letter or report form.

SECTION A: CHEMICAL(S) (Check each one which applies for your company)		
<input type="checkbox"/> Nano Silver	<input type="checkbox"/> Nano Titanium Dioxide	<input type="checkbox"/> Nano Cerium Oxide
<input type="checkbox"/> Nano Zero Valent Iron	<input type="checkbox"/> Nano Zinc Oxide	<input checked="" type="checkbox"/> Quantum Dot(s)

SECTION B: BUSINESS IDENTIFICATION INFORMATION (check one and complete 1 – 10)				
<input type="checkbox"/> Sole Owner	<input checked="" type="checkbox"/> Corporation	<input type="checkbox"/> Limited Liability Company (LLC)	<input type="checkbox"/> Limited Liability Partnership (LLP)	<input type="checkbox"/> Unincorporated Business Trust
<input type="checkbox"/> Spouses' Co-ownership	<input type="checkbox"/> Registered Domestic Partnership	<input type="checkbox"/> General Partnership	<input type="checkbox"/> Limited Partnership	<input type="checkbox"/> Other: (describe)
1. Name of Sole Owner, Corporation, Partnership, Institute, Other. Life Technologies Corporation				
2. Business Trade Name ("Doing Business As," if any) None				
3. Business Address (physical location of your business: street number and name, city, state, country, zip or postal code) 5791 Van Allen Way, Carlsbad, California 92008, USA				
4. Mailing Address (street name and number, P.O. box, city, state, country, zip or postal code, if different from 3) The Same as Above				
5. Business Website Address(es): http://www.lifetechnologies.com				
6. Name of Owner, Responsible Corporate Officer, Partner, Other. Sang-Tae Kim				
7. Contact Information for Person in 6 above.				
Name: Sang-Tae Kim		Title: Design-for-Environment/EHS		
Business Telephone: 650-554-2798		Email: sang-tae.kim@lifetech.com		
8. Number of Employees (California employees). 2908				
9. NAICS Code(s) for this business:		Primary: 325413	Other:	Other:
10. Nano Chemical Business Type: (check applicable)		<input checked="" type="checkbox"/> Manufacturer	<input checked="" type="checkbox"/> Importer	<input checked="" type="checkbox"/> Researcher

SECTION C: CERTIFICATION (FOR THIS COMPLETE SUBMITTAL)		
I am fully authorized to prepare and submit this information, as a formal response to the request pursuant to Health and Safety Code section 57019(d)(1), and certify the information and statements made herein, and in the attachments, are correct to the best of my knowledge and belief.		
Name: (type or print) Sang-Tae Kim	Signature: 	Date: December 15, 2011

SECTION D: NANOMATERIAL CHEMICAL AND PHYSICAL PROPERTIES (Attach additional pages as needed)		
PRODUCT / PRODUCTION INFORMATION		
NANO CHEMICAL NAME: Qdot® ITK™ amino (PEG) quantum dots		
COMMERCIAL NAME(S): Qdot® 525 ITK™ amino (PEG) quantum dots *8 µM solution*; Qdot® 545 ITK™ amino (PEG) quantum dots *8 µM solution*; Qdot® 565 ITK™ amino (PEG) quantum dots *8 µM solution*; Qdot® 585 ITK™ amino (PEG) quantum dots *8 µM solution*; Qdot® 605 ITK™ amino (PEG) quantum dots *8 µM solution*; Qdot® 655 ITK™ amino (PEG) quantum dots *8 µM solution*; Qdot® 705 ITK™ amino (PEG) quantum dots *8 µM solution*; Qdot® 800 ITK™ amino (PEG) quantum dots *8 µM solution*		
ANNUAL PRODUCTION VOLUME: Total annual production is 2.082 grams. Quantity shipped to California is 0.112 gram.		
PRODUCTION METHOD(S): Core and core-shell nanoparticles are produced using common colloidal synthesis techniques. Some examples may be found in the following patents: 6,322,901; 6,815,064; 7,147,712; 7,695,642. Some examples of methods for applying the amphiphilic coating to these particles to render them water soluble may be found in the following patent 6,649,138.		
IDENTIFICATION OF THE SUPPLIER(S): Life Technologies is the producer and supplier of these products.		
PARAMETER	VALUE / RANGE	NAME OF ANALYTICAL METHOD(S)
PHYSICAL PROPERTIES		
SHAPE (MORPHOLOGY)	The morphology of a nanoparticle is most commonly measured by transmission electron microscopy (TEM) since it is the only analytical technique with resolution sufficient to resolve the fine features of a nanoparticle. This technique is limited, however, since it is most sensitive to electron dense elements of the nanoparticle like cadmium, zinc and selenium and virtually insensitive to lighter elements like carbon, hydrogen, oxygen and nitrogen. This means that shape and morphology information is not available for nanoparticles that comprise organic coatings. In other words, TEM can only give you information about the nanocrystal within a nanoparticle. TEM is further limited by the fact that the data acquired is only a two dimensional projection of the three dimensional shape. Therefore to calculate the volume or surface area, a three dimensional shape must be assumed. The size of the nanoparticle (nanocrystal and organic ligands) can be measured by size exclusion chromatography (SEC) but this technique does not have the resolution to provide morphology information.	
DENSITY	The density of these materials has not been measured	
SURFACE AREA	Since we cannot measure the morphology of Qdot® ITK™ amino (PEG) quantum dot nanoparticles, we cannot calculate the surface area. If we approximate the morphology as a sphere and use the SEC sizing data, we can calculate a spherical surface area.	
PARTICLE SIZE DISTRIBUTION	Air	To the best of our knowledge, no technique is currently available
	Liquid	Dynamic light scattering can give particle size distribution data, however, several complications exist in interpreting the data. Some of those caveats include, (1) since quantum dots have broad absorbance, any color that emits at longer wavelengths than the laser will absorb some of the laser light and make interpretation of the data nearly impossible, (2) large particles scatter much more efficiently than smaller particles making detection of small particle populations difficult.
	Solid/ Powder	To the best of our knowledge, no technique is currently available
OTHER (SPECIFY)		

CHEMICAL PROPERTIES			
CHEMICAL COMPOSITION		The inorganic portion of the nanoparticles (nanocrystal) is composed of cadmium, selenium, zinc and sulfur. Two of our nanocrystal products (Qdot 705 and 800) additionally contain tellurium. The exact composition of the ligand shell is unknown but NMR has revealed that it is mostly composed of tetradecylphosphonic acid (TDPA) and/or other phosphorus-containing species. The polymer coating is an amphiphilic molecule that is associated with the nanoparticle and provides water solubility. The polyethylene glycol (PEG) coating is attached to the polymer coating through amide bonds created by reacting amine-functional PEG molecules with carbodiimide (e.g., 1-Ethyl-3-[3-dimethylaminopropyl]carbodiimide hydrochloride) activated carboxylate groups on the polymer coating.	The chemical composition of this polymer is best described in Patent Number 6,649,138
SURFACE MODIFICATION (COATING, FUNCTIONALIZATION)		The outer surface contains an amphiphilic polymer and polyethylene glycol	The process of applying this polymer to the nanoparticles is best described in patent number 6,649,138.
PURITY		Purity is essential for our products. We have most routinely use SEC to detect and measure impurities. Some of those impurities include aggregated nanoparticles, free (unbound) amphiphilic polymer, and other nanoparticle impurities.	
SURFACE CHARGE		We routinely perform gel electrophoresis to confirm the charge of a particle but we do not quantitate it in terms of charge density.	
DISPERSION	Air	We do not handle air dispersions in our operations or R&D	
	Liquid	Presence of aggregated particles is routinely measured by SEC chromatography. In fact, all of our products and water soluble intermediates have specifications around the percentage of these soluble aggregates present in the solution.	
	Solid	We do not handle the materials in the solid form, but as a liquid dispersion.	
IDENTIFYING AND DETERMINING CONCENTRATION OF NANO CHEMICAL, ITS METABOLITES, AND DEGRADATION PRODUCTS IN SPECIFIED MATRICES (Water, Air, Soil, Sediment, Sludge, Chemical Waste, Fish, Blood, Adipose Tissue, Urine, Other)		Determining the exact concentration of nanoparticles in any matrix is difficult because routine nanoparticle counting techniques do not currently exist. The most common method for determining the concentration of quantum dots is to measure the optical absorbance in solution at a concentration where Beer's law is operative and calculate the concentration using an estimated extinction coefficient for the material.	A example of a common technique for estimating the extinction coefficient for quantum dot can be found in this reference (Chem. Mater. 2003, 15, 2854-2860)
SOLUBILITY	Water Solubility	Soluble/miscible in water. These products are sold at a concentration of 8 micromolar which is in the range of 0.5 mg/mL to 8 mg/mL depending on the color.	
	Solubility in Organic Solvent	Not soluble/miscible in organic solvent	
N-OCTANOL-WATER PARTITION COEFFICIENT		We have not measured this parameter.	
STABILITY AND REACTIVITY	Flammability	These nanoparticle products are sold as dilute (8 µM or approximately 0.5 mg to 8 mg/mL) aqueous solutions and are therefore classified with a HMIS flammability rating of 0 (same as water).	

Explosiveness	These products do not pose an explosion hazard. This conclusion is partially based on thermogravimetric analysis (TGA) of our ITK organic quantum dots. TGA shows that no weight loss occurs until about 300 °C. At around 300 °C the particles lose about 10 - 20 % of their mass. This temperature coincides with the boiling point of the organic ligands used in the synthesis of quantum dots. No other weight loss is observed up to a temperature of 650 °C.	
Oxidizing Properties	These products are not strong oxidizing agents.	
Oxidation Reduction Potential	These products are not strong reducing agents.	
Storage Stability and Reactivity (Container Material)	These products are stable in a variety of container materials including, glass and plastic. The product is packaged and shipped in polypropylene vials.	
Stability to Thermal, Sunlight, and Metal(s)	These products are stable, meaning that they will work for their intended purpose, to multiple rounds of freezing and thawing and moderately high temperatures (0 °C to 37 °C). These products are stable and will work for their intended purpose with moderate sunlight exposure. Some metals will quench the florescence from these particles. Particularly copper (II) and iron (III).	Reference - Cytometry Part A, 79A: 84 89, 2011

SECTION E: Provide a copy of your Globally Harmonized System (GHS) Safety Data Sheet (SDS), if you have prepared one.
 Attached is current SDS/Material Safety Data Sheet (MSDS). See Attachment 1

SECTION F: For each nanomaterial you produce or import, describe the analytical test method(s) that you use, or plan to use, to sample, prepare, and analyze a specific matrix to determine the identity and concentration of each specified nanomaterial. Use a separate page to describe the procedure for each, individual matrix, which must include water, air, soil, sediment, sludge, chemical waste, fish, blood, adipose tissue, and urine. Include the information requested in Section D above.

Life Technologies' *Medical Surveillance and Monitoring Plan* requires a bi-annual monitoring of blood and urine samples as well as an annual physical examination of employees who are involved in manufacturing of quantum dots. No cadmium was detectable from either blood or urine samples, when analyzed with the use of Inductively Coupled Plasma/Mass Spectrometry (ICP-MS) (see <http://www.aruplab.com/guides/ug/tests/0025040.jsp> for detailed information on sampling and analysis methodology).

We have not determined the identity and concentration of Qdot® ITK™ amino (PEG) quantum dot nanocrystals in environmental matrix including air, soil, sediment, sludge, chemical waste, fish, and adipose tissue.

ATTACHMENT 1
MATERIAL SAFETY DATA SHEET
(Sample)



SAFETY DATA SHEET

1. Identification of the substance/mixture and of the company/undertaking

Identification of the substance/preparation

Product code Q21541MP
Product name Qdot® 525 ITK™ amino (PEG) quantum dots

Company/Undertaking Identification

Life Technologies
5791 VAN ALLEN WAY
PO BOX 6482
CARLSBAD, CA 92008
+1 760 803 7200

INVITROGEN CORPORATION
5250 MAINWAY DRIVE
BURLINGTON, ONT
CANADA L7L 6A4
800/263-6236

24 hour Emergency Response (Transport): 866-536-0631
301-431-8585
Outside of the U.S. +1-301-431-8585

For research use only. Not intended for human or animal diagnostic or therapeutic uses.

Revision Date 29-Nov-2011
Product code Q21541MP

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Product name Qdot® 525 ITK™ amino (PEG) quantum dots

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2. Hazards identification

GHS - Classification

Signal Word
not hazardous

Health Hazard
not hazardous

Physical Hazards
not hazardous

**Principle Routes of Exposure/
Potential Health effects**

Eyes	May cause eye irritation with susceptible persons.
Skin	May cause skin irritation in susceptible persons.
Inhalation	May be harmful by inhalation.
Ingestion	May be harmful if swallowed.

Specific effects

Carcinogenic effects	none.
Mutagenic effects	none.
Reproductive toxicity	none.
Sensitization	none.

Target Organ Effects No known effects under normal use conditions

HMIS

Health	0
Flammability	0
Reactivity	0

3. Composition/information on ingredients

The product contains no substances which at their given concentration, are considered to be hazardous to health. We recommend handling all chemicals with caution.

4. First aid measures

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Product code Q21541MP

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Product name Qdot® 525 ITK™ amino (PEG) quantum dots

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Skin contact	Rinse with plenty of water. If symptoms arise, call a physician.
Eye contact	Rinse immediately with plenty of water, also under the eyelids, for at least 15 minutes. If symptoms persist, call a physician.
Ingestion	Never give anything by mouth to an unconscious person. If symptoms persist, call a physician. Do not induce vomiting without medical advice.
Inhalation	Move to fresh air. If symptoms persist, call a physician. If not breathing, give artificial respiration.
Notes to physician	Treat symptomatically.

5. Fire-fighting measures

Suitable extinguishing media	Water spray. Carbon dioxide (CO2). Foam. Dry chemical.
Special protective equipment for firefighters	Wear self-contained breathing apparatus and protective suit.

6. Accidental release measures

Personal precautions	Use personal protective equipment.
Methods for cleaning up	Soak up with inert absorbent material.

Environmental precautions

Prevent further leakage or spillage if safe to do so.

See Section 12 for additional information.

7. Handling and storage

Handling	Always wear recommended Personal Protective Equipment. No special handling advice required.
Storage	Keep in a dry, cool and well-ventilated place.

8. Exposure controls/personal protection

Exposure limits

At this time, the limited evidence available suggests caution when potential exposures to nanoparticles may occur. Due to the limited information about health risks from nanomaterials, it is prudent to take steps for minimizing worker exposures. Research is still needed to understand the impact of nanotechnology on health, and to determine appropriate exposure monitoring and control strategies.

Engineering measures	Ensure adequate ventilation, especially in confined areas.
-----------------------------	--

Personal protective equipment

Respiratory protection	In case of insufficient ventilation wear suitable respiratory equipment.
-------------------------------	--

Hand protection	Impervious gloves.
Eye protection	Safety glasses with side-shields.
Skin and body protection.	Lightweight protective clothing.
Hygiene measures	Handle in accordance with good industrial hygiene and safety practice.

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Product code Q21541MP

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Product name Qdot® 525 ITK™ amino (PEG) quantum dots

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Environmental exposure controls

Prevent product from entering drains.

9. Physical and chemical properties

General Information

Form	suspension	
Appearance	liquid	
Odor	No information available	
Boiling Point/Range	°C no data available	°F no data available
Melting point/Range	°C no data available	°F no data available
Flash point	°C no data available	°F no data available
Autoignition temperature	°C no data available	°F no data available
Oxidizing properties	No information available.	
Water solubility	soluble	
pH VALUE	8.3	

10. Stability and reactivity

Stability	Stable under normal conditions.
Materials to avoid	No dangerous reaction known under conditions of normal use.
Hazardous decomposition products	None under normal use
polymerization	Hazardous polymerisation does not occur.

11. Toxicological information

Acute toxicity

At this time, the limited evidence available suggests caution when potential exposures to nanoparticles may occur. Due to the limited information about health risks from nanomaterials, it is prudent to take steps for minimizing worker exposures. Occupational health risks associated with manufacturing and using nanomaterials are not yet clearly understood. Studies have indicated that low solubility nanoparticles are more toxic than larger particles on a mass for mass basis. There are strong indications that particle surface area and surface chemistry are responsible for observed responses in cell cultures and animals. There are indications that nanoparticles can penetrate through the skin or move from the respiratory system to other organs.

Principle Routes of Exposure/

Potential Health effects

Eyes	May cause eye irritation with susceptible persons.
Skin	May cause skin irritation in susceptible persons.
Inhalation	May be harmful by inhalation.
Ingestion	May be harmful if swallowed.
Carcinogenic effects	none
Mutagenic effects	none
Reproductive toxicity	none
Sensitization	none
Target Organ Effects	No known effects under normal use conditions

Revision Date 20-Nov-2011
 Product code Q2154IMP

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 Product name Qdot® 525 ITK™ amino (PEG) quantum dots

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12. Ecological information

Ecotoxicity effects	No information available.
Mobility	No information available.
Biodegradation	Inherently biodegradable
Bioaccumulation	Does not bioaccumulate.

13. Disposal considerations

Dispose of in accordance with local regulations.

14. Transport information

IATA

Proper shipping name	Not classified as dangerous in the meaning of transport regulations
Hazard class	none
Subsidiary Class	none
Packing group	none
UN-No	None

15. Regulatory information

U.S. Federal Regulations

SARA 313

This product contains the following toxic chemical(s) subject to the notification requirements of section 313 of Title III of the Superfund Amendments and Reauthorization Act of 1986. This law requires certain manufacturers to report on annual emissions of specified chemicals and chemical categories. Please note that if you repackage, or otherwise redistribute, this product to industrial customers, a notice similar to this one should be sent to those customers:

Clean Air Act, Section 112 Hazardous Air Pollutants (HAPs) (see 40 CFR 61)

This product does not contain HAPs.

U.S. State Regulations

California Proposition 65

This product does not contain chemicals listed under Proposition 65

WHMIS hazard class:

Non-controlled

This product has been classified according to the hazard criteria of the CPR and the MSDS contains all of the information required by the CPR

16. Other information

Reason for Revision (M)SDS sections updated.

Revision Date 28-Nov-2011
Product code Q2154 IMP

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Product name Qdot® 525 ITK™ amino (PEG) quantum dots

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For research use only. Not intended for human or animal diagnostic or therapeutic uses.

References

- National Institute for Occupational Safety and Health (NIOSH), U.S., 2010:
<http://www.cdc.gov/niosh/topics/nanotech/>
- National Institute for Occupational Safety and Health (NIOSH), U.S., 2009:
<http://www.cdc.gov/niosh/docs/2009-125/pdfs/2009-125.pdf>

The above information was acquired by diligent search and/or investigation and the recommendations are based on prudent application of professional judgment. The information shall not be taken as being all inclusive and is to be used only as a guide. All materials and mixtures may present unknown hazards and should be used with caution. Since the Company cannot control the actual methods, volumes, or conditions of use, the Company shall not be held liable for any damages or losses resulting from the handling or from contact with the product as described herein. THE INFORMATION IN THIS MSDS DOES NOT CONSTITUTE A WARRENTY, EXPRESSED OR IMPLIED, INCLUDING ANY IMPLIED WARRANTY OF MERCHANTABILITY OR FITNESS FOR ANY PARTICULAR PUPOSE.

End of Safety Data Sheet

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Product code Q2154IMP

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STATE OF CALIFORNIA
Department of Toxic Substances Control

Health and Safety Code Section 57019 Chemical Information Call-in Information
For Nanometals, Nanometal Oxides, and Quantum Dots
December 2010

This enclosure is provided for your convenience. You may provide the requested information in writing, and attaching any supplementary materials or explanatory information, in letter or report form.

SECTION A: CHEMICAL(S) (Check each one which applies for your company)		
<input type="checkbox"/> Nano Silver	<input type="checkbox"/> Nano Titanium Dioxide	<input type="checkbox"/> Nano Cerium Oxide
<input type="checkbox"/> Nano Zero Valent Iron	<input type="checkbox"/> Nano Zinc Oxide	<input checked="" type="checkbox"/> Quantum Dot(s)

SECTION B: BUSINESS IDENTIFICATION INFORMATION (check one and complete 1 – 10)				
<input type="checkbox"/> Sole Owner	<input checked="" type="checkbox"/> Corporation	<input type="checkbox"/> Limited Liability Company (LLC)	<input type="checkbox"/> Limited Liability Partnership (LLP)	<input type="checkbox"/> Unincorporated Business Trust
<input type="checkbox"/> Spouses' Co-ownership	<input type="checkbox"/> Registered Domestic Partnership	<input type="checkbox"/> General Partnership	<input type="checkbox"/> Limited Partnership	<input type="checkbox"/> Other: (describe)
1. Name of Sole Owner, Corporation, Partnership, Institute, Other. Life Technologies Corporation				
2. Business Trade Name ("Doing Business As," if any) None				
3. Business Address (physical location of your business: street number and name, city, state, country, zip or postal code) 5791 Van Allen Way, Carlsbad, California 92008, USA				
4. Mailing Address (street name and number, P.O. box, city, state, country, zip or postal code, if different from 3) The Same as Above				
5. Business Website Address(es): http://www.lifetechnologies.com				
6. Name of Owner, Responsible Corporate Officer, Partner, Other. Sang-Tae Kim				
7. Contact Information for Person in 6 above.				
Name: Sang-Tae Kim		Title: Design-for-Environment/EHS		
Business Telephone: 650-554-2798		Email: sang-tae.kim@lifetech.com		
8. Number of Employees (California employees). 2908				
9. NAICS Code(s) for this business:		Primary: 325413	Other:	Other:
10. Nano Chemical Business Type: (check applicable)		<input checked="" type="checkbox"/> Manufacturer	<input checked="" type="checkbox"/> Importer	<input checked="" type="checkbox"/> Researcher

SECTION C: CERTIFICATION (FOR THIS COMPLETE SUBMITTAL)		
I am fully authorized to prepare and submit this information, as a formal response to the request pursuant to Health and Safety Code section 57019(d)(1), and certify the information and statements made herein, and in the attachments, are correct to the best of my knowledge and belief.		
Name: (type or print) Sang-Tae Kim	Signature: 	Date: December 15, 2011

SECTION D: NANOMATERIAL CHEMICAL AND PHYSICAL PROPERTIES (Attach additional pages as needed)		
PRODUCT / PRODUCTION INFORMATION		
NANO CHEMICAL NAME: Qdot® Biotin Conjugate Kit		
COMMERCIAL NAME(S): Qdot® 605 Biotin Conjugate Kit; Qdot® 655 Biotin Conjugate Kit		
ANNUAL PRODUCTION VOLUME: Total annual production is 0.039 gram. Quantity shipped to California is 0.003 gram.		
PRODUCTION METHOD(S): Core and core-shell nanoparticles are produced using common colloidal synthesis techniques. Some examples may be found in the following patents: 6,322,901; 6,815,064; 7,147,712; 7,695,642. Some examples of methods for applying the amphiphilic coating to these particles to render them water soluble may be found in the following patent 6,649,138.		
IDENTIFICATION OF THE SUPPLIER(S): Life Technologies is the producer and supplier of these products.		
PARAMETER	VALUE / RANGE	NAME OF ANALYTICAL METHOD(S)
PHYSICAL PROPERTIES		
SHAPE (MORPHOLOGY)	The morphology of a nanoparticle is most commonly measured by transmission electron microscopy (TEM) since it is the only analytical technique with resolution sufficient to resolve the fine features of a nanoparticle. This technique is limited, however, since it is most sensitive to electron dense elements of the nanoparticle like cadmium, zinc and selenium and virtually insensitive to lighter elements like carbon, hydrogen, oxygen and nitrogen. This means that shape and morphology information is not available for nanoparticles that comprise organic coatings. In other words, TEM can only give you information about the nanocrystal within a nanoparticle. TEM is further limited by the fact that the data acquired is only a two dimensional projection of the three dimensional shape. Therefore to calculate the volume or surface area, a three dimensional shape must be assumed. The size of the nanoparticle (nanocrystal and organic ligands) can be measured by size exclusion chromatography (SEC) but this technique does not have the resolution to provide morphology information.	
DENSITY	The density of these materials has not been measured	
SURFACE AREA	Since we cannot measure the morphology of Qdot® Biotin Conjugate Kit nanoparticles, we cannot calculate the surface area. If we approximate the morphology as a sphere and use the SEC sizing data, we can calculate a spherical surface area.	
PARTICLE SIZE DISTRIBUTION	Air	To the best of our knowledge, no technique is currently available
	Liquid	Dynamic light scattering can give particle size distribution data, however, several complications exist in interpreting the data. Some of those caveats include, (1) since quantum dots have broad absorbance, any color that emits at longer wavelengths than the laser will absorb some of the laser light and make interpretation of the data nearly impossible, (2) large particles scatter much more efficiently than smaller particles making detection of small particle populations difficult.
	Solid/ Powder	To the best of our knowledge, no technique is currently available
OTHER (SPECIFY)		
CHEMICAL PROPERTIES		
CHEMICAL COMPOSITION	The inorganic portion of the nanoparticles (nanocrystal) is composed of cadmium, selenium, zinc and sulfur. The exact composition of the ligand shell is unknown but NMR	The chemical composition of this polymer is best

		has revealed that it is mostly composed of tetradecylphosphonic acid (TDPA) and/or other phosphorus-containing species. The polymer coating is an amphiphilic molecule that is associated with the nanoparticle and provides water solubility. The polyethylene glycol (PEG) coating and biotin functionality is attached to the polymer coating through amide bonds created by reacting bifunctional (e.g., amine and biotin) PEG molecules with carbodiimide (e.g., 1-Ethyl-3-[3-dimethylaminopropyl]carbodiimide hydrochloride) activated carboxylate groups on the polymer coating.	described in Patent Number 6,649,138
SURFACE MODIFICATION (COATING, FUNCTIONALIZATION)		The outer surface contains an amphiphilic polymer, polyethylene glycol and biotin.	The process of applying this polymer to the nanoparticles is best described in patent number 6,649,138.
PURITY		Purity is essential for our products. We have most routinely use SEC to detect and measure impurities. Some of those impurities include aggregated nanoparticles, free (unbound) amphiphilic polymer, and other nanoparticle impurities.	
SURFACE CHARGE		We routinely perform gel electrophoresis to confirm the charge of a particle but we do not quantitate it in terms of charge density.	
DISPERSION	Air	We do not handle air dispersions in our operations or R&D	
	Liquid	Presence of aggregated particles is routinely measured by SEC chromatography. In fact, all of our products and water soluble intermediates have specifications around the percentage of these soluble aggregates present in the solution.	
	Solid	We do not handle the materials in the solid form, but as a liquid dispersion.	
IDENTIFYING AND DETERMINING CONCENTRATION OF NANO CHEMICAL, ITS METABOLITES, AND DEGRADATION PRODUCTS IN SPECIFIED MATRICES (Water, Air, Soil, Sediment, Sludge, Chemical Waste, Fish, Blood, Adipose Tissue, Urine, Other)		Determining the exact concentration of nanoparticles in any matrix is difficult because routine nanoparticle counting techniques do not currently exist. The most common method for determining the concentration of quantum dots is to measure the optical absorbance in solution at a concentration where Beer's law is operative and calculate the concentration using an estimated extinction coefficient for the material.	A example of a common technique for estimating the extinction coefficient for quantum dot can be found in this reference (Chem. Mater. 2003, 15, 2854-2860)
SOLUBILITY	Water Solubility	Soluble/miscible in water. These products are sold at a concentration of 2 micromolar which is in the range of 0.125 mg/mL to 2 mg/mL depending on the color.	
	Solubility in Organic Solvent	Not soluble/miscible in organic solvent	
N-OCTANOL-WATER PARTITION COEFFICIENT		We have not measured this parameter.	
STABILITY AND REACTIVITY	Flammability	These nanoparticle products are sold as dilute (2 µM or approximately 0.125 mg to 2 mg/mL) aqueous solutions and are therefore classified with a HMIS flammability rating of 0 (same as water).	
	Explosiveness	These products do not pose an explosion hazard. This conclusion is partially based on thermogravimetric analysis (TGA) of our ITK organic quantum dots. TGA shows that no weight loss occurs until about 300 °C. At around 300 °C the particles lose about 10 - 20 % of their mass. This	

		temperature coincides with the boiling point of the organic ligands used in the synthesis of quantum dots. No other weight loss is observed up to a temperature of 650 °C.	
	Oxidizing Properties	These products are not strong oxidizing agents.	
	Oxidation Reduction Potential	These products are not strong reducing agents.	
	Storage Stability and Reactivity (Container Material)	These products are stable in a variety of container materials including, glass and plastic. The product is packaged and shipped in polypropylene vials.	
	Stability to Thermal, Sunlight, and Metal(s)	These products are stable, meaning that they will work for their intended purpose, to multiple rounds of freezing and thawing and moderately high temperatures (0 °C to 37 °C). These products are stable and will work for their intended purpose with moderate sunlight exposure. Some metals will quench the fluorescence from these particles. Particularly copper (II) and iron (III).	Reference - Cytometry Part A, 79A: 84 89, 2011

SECTION E: Provide a copy of your Globally Harmonized System (GHS) Safety Data Sheet (SDS), if you have prepared one.

Attached is current SDS/Material Safety Data Sheet (MSDS). See Attachment 1

SECTION F: For each nanomaterial you produce or import, describe the analytical test method(s) that you use, or plan to use, to sample, prepare, and analyze a specific matrix to determine the identity and concentration of each specified nanomaterial. Use a separate page to describe the procedure for each, individual matrix, which must include water, air, soil, sediment, sludge, chemical waste, fish, blood, adipose tissue, and urine. Include the information requested in Section D above.

Life Technologies' *Medical Surveillance and Monitoring Plan* requires a bi-annual monitoring of blood and urine samples as well as an annual physical examination of employees who are involved in manufacturing of quantum dots. No cadmium was detectable from either blood or urine samples, when analyzed with the use of Inductively Coupled Plasma/Mass Spectrometry (ICP-MS) (see <http://www.aruplab.com/guides/ug/tests/0025040.jsp> for detailed information on sampling and analysis methodology).

We have not determined the identity and concentration of Qdot® Biotin Conjugate Kit nanoparticles in environmental matrix including air, soil, sediment, sludge, chemical waste, fish, and adipose tissue.

ATTACHMENT 1
MATERIAL SAFETY DATA SHEET
(Sample)



SAFETY DATA SHEET

1. Identification of the substance/mixture and of the company/undertaking

Identification of the substance/preparation

Product code Q10301MPCOMPONENTA
Product name Qdot® 605 biotin conjugate *2 µM solution*

Company/Undertaking Identification

Life Technologies
5791 VAN ALLEN WAY
PO BOX 6482
CARLSBAD, CA 92008
+1 760 603 7200

INVITROGEN CORPORATION
5250 MAINWAY DRIVE
BURLINGTON, ONT
CANADA L7L 6A4
800/263-6236

24 hour Emergency Response (Transport):

866-536-0631
301-431-8585
Outside of the U.S. +1-301-431-8585

For research use only. Not intended for human or animal diagnostic or therapeutic uses.

Revision Date 28-Nov-2011
Product code Q10301MPCOMPONENTA

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Product name Qdot® 605 biotin conjugate *2 µM solution*

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2. Hazards identification

GHS - Classification

Signal Word
not hazardous

Health Hazard
not hazardous

Physical Hazards
not hazardous

**Principle Routes of Exposure/
Potential Health effects**

Eyes	May cause eye irritation with susceptible persons.
Skin	May cause skin irritation in susceptible persons.
Inhalation	May be harmful by inhalation.
Ingestion	May be harmful if swallowed.

Specific effects

Carcinogenic effects	none.
Mutagenic effects	none.
Reproductive toxicity	none.
Sensitization	none.

Target Organ Effects No known effects under normal use conditions

HMIS

Health	0
Flammability	0
Reactivity	0

3. Composition/information on ingredients

Chemical Name	CAS-No	EINECS-No	Weight %
Sodium azide	26628-22-8	247-852-1	<0.1

The product contains no substances which at their given concentration, are considered to be hazardous to health. We recommend handling all chemicals with caution.

Revision Date 29-Nov-2011
Product code Q10301MPCOMPONENTA

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Product name Qdot® 605 biotin conjugate '2 µM solution'

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4. First aid measures

Skin contact	Rinse with plenty of water. If symptoms arise, call a physician.
Eye contact	Rinse immediately with plenty of water, also under the eyelids, for at least 15 minutes. If symptoms persist, call a physician.
Ingestion	Never give anything by mouth to an unconscious person. If symptoms persist, call a physician. Do not induce vomiting without medical advice.
Inhalation	Move to fresh air. If symptoms persist, call a physician. If not breathing, give artificial respiration.
Notes to physician	Treat symptomatically.

5. Fire-fighting measures

Suitable extinguishing media	Water spray. Carbon dioxide (CO ₂). Foam. Dry chemical.
Special protective equipment for firefighters	Wear self-contained breathing apparatus and protective suit.

6. Accidental release measures

Personal precautions	Use personal protective equipment.
Methods for cleaning up	Soak up with inert absorbent material.

Environmental precautions

Prevent further leakage or spillage if safe to do so.

See Section 12 for additional information.

7. Handling and storage

Handling	Always wear recommended Personal Protective Equipment. No special handling advice required.
Storage	Keep in a dry, cool and well-ventilated place.

8. Exposure controls/personal protection

Exposure limits

At this time, the limited evidence available suggests caution when potential exposures to nanoparticles may occur. Due to the limited information about health risks from nanomaterials, it is prudent to take steps for minimizing worker exposures. Research is still needed to understand the impact of nanotechnology on health, and to determine appropriate exposure monitoring and control strategies.

Engineering measures	Ensure adequate ventilation, especially in confined areas.
-----------------------------	--

Personal protective equipment

Respiratory protection	In case of insufficient ventilation wear suitable respiratory equipment.
Hand protection	Impervious gloves.
Eye protection	Safety glasses with side-shields.
Skin and body protection.	Lightweight protective clothing.

Hygiene measures Handle in accordance with good industrial hygiene and safety practice.

Environmental exposure controls Prevent product from entering drains.

9. Physical and chemical properties

General Information

Form	suspension	
Appearance	liquid	
Odor	No information available	
Boiling Point/Range	°C no data available	°F no data available
Melting point/range	°C no data available	°F no data available
Flash point	°C no data available	°F no data available
Autoignition temperature	°C no data available	°F no data available
Oxidizing properties	No information available.	
Water solubility	soluble	
pH VALUE	8.3	

10. Stability and reactivity

Stability	Stable under normal conditions.
Materials to avoid	No dangerous reaction known under conditions of normal use.
Hazardous decomposition products	None under normal use
polymerization	Hazardous polymerisation does not occur.

11. Toxicological information

Acute toxicity

At this time, the limited evidence available suggests caution when potential exposures to nanoparticles may occur. Due to the limited information about health risks from nanomaterials, it is prudent to take steps for minimizing worker exposures. Occupational health risks associated with manufacturing and using nanomaterials are not yet clearly understood. Studies have indicated that low solubility nanoparticles are more toxic than larger particles on a mass for mass basis. There are strong indications that particle surface area and surface chemistry are responsible for observed responses in cell cultures and animals. There are indications that nanoparticles can penetrate through the skin or move from the respiratory system to other organs.

Chemical Name	LD50 (oral, rat/mouse)	LD50 (dermal, rathabbit)	LC50 (inhalation, rat/mouse)
Sodium azide	= 27 mg/kg (Rat)	no data available	no data available

Principle Routes of Exposure/

Potential Health effects

Eyes	May cause eye irritation with susceptible persons.
Skin	May cause skin irritation in susceptible persons.
Inhalation	May be harmful by inhalation.
Ingestion	May be harmful if swallowed.
Carcinogenic effects	none
Mutagenic effects	none

Revision Date 29-Nov-2011
 Product code Q10301MPCOMPONENTA

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 Product name Qdot® 605 biotin conjugate *2 µM solution*

Reproductive toxicity	none
Sensitization	none
Target Organ Effects	No known effects under normal use conditions

12. Ecological information

Ecotoxicity effects	No information available.
Mobility	No information available.
Biodegradation	Inherently biodegradable
Bioaccumulation	Does not bioaccumulate.

13. Disposal considerations

Dispose of in accordance with local regulations.

14. Transport information

IATA

Proper shipping name	Not classified as dangerous in the meaning of transport regulations
Hazard class	none
Subsidiary Class	none
Packing group	none
UN-No	None

15. Regulatory information

Component	TSCA
Sodium azide 28628-22-8 (<0.1)	Listed

U.S. Federal Regulations**SARA 313**

This product contains the following toxic chemical(s) subject to the notification requirements of section 313 of Title III of the Superfund Amendments and Reauthorization Act of 1986. This law requires certain manufacturers to report on annual emissions of specified chemicals and chemical categories. Please note that if you repackaged, or otherwise redistribute, this product to industrial customers, a notice similar to this one should be sent to those customers:

Chemical Name	CAS-No	Weight %	SARA 313 - Threshold Values
Sodium azide	28628-22-8	<0.1	1.0

Clean Air Act, Section 112 Hazardous Air Pollutants (HAPs) (see 40 CFR 61)

This product does not contain HAPs.

U.S. State Regulations

Chemical Name	Massachusetts - RTK	New Jersey - RTK	Pennsylvania - RTK	Illinois - RTK	Rhode Island - RTK
Sodium azide	Listed	Listed	Listed	-	Listed

California Proposition 65

This product does not contain chemicals listed under Proposition 65

WHMIS hazard class:

Non-controlled

This product has been classified according to the hazard criteria of the CFR and the MSDS contains all of the information required by the CFR

16. Other information

Reason for Revision (M)SDS sections updated.

For research use only. Not intended for human or animal diagnostic or therapeutic uses.

References

- National Institute for Occupational Safety and Health (NIOSH), U.S., 2010:
<http://www.cdc.gov/niosh/topics/nanotech/>
- National Institute for Occupational Safety and Health (NIOSH), U.S., 2009:
<http://www.cdc.gov/niosh/docs/2009-125/pdfs/2009-125.pdf>

The above information was acquired by diligent search and/or investigation and the recommendations are based on prudent application of professional judgment. The information shall not be taken as being all inclusive and is to be used only as a guide. All materials and mixtures may present unknown hazards and should be used with caution. Since the Company cannot control the actual methods, volumes, or conditions of use, the Company shall not be held liable for any damages or losses resulting from the handling or from contact with the product as described herein. THE INFORMATION IN THIS MSDS DOES NOT CONSTITUTE A WARRANTY, EXPRESSED OR IMPLIED, INCLUDING ANY IMPLIED WARRANTY OF MERCHANTABILITY OR FITNESS FOR ANY PARTICULAR PURPOSE.

End of Safety Data Sheet

Revision Date 28-Nov-2011
Product code Q10301MFCOMPONENTA

Page 6/7
Product name Qdot® 605 biotin conjugate '2 µM solution'

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STATE OF CALIFORNIA
Department of Toxic Substances Control

Health and Safety Code Section 57019 Chemical Information Call-in Information
For Nanometals, Nanometal Oxides, and Quantum Dots
December 2010

This enclosure is provided for your convenience. You may provide the requested information in writing, and attaching any supplementary materials or explanatory information, in letter or report form.

SECTION A: CHEMICAL(S) (Check each one which applies for your company)		
<input type="checkbox"/> Nano Silver	<input type="checkbox"/> Nano Titanium Dioxide	<input type="checkbox"/> Nano Cerium Oxide
<input type="checkbox"/> Nano Zero Valent Iron	<input type="checkbox"/> Nano Zinc Oxide	<input checked="" type="checkbox"/> Quantum Dot(s)

SECTION B: BUSINESS IDENTIFICATION INFORMATION (check one and complete 1 – 10)				
<input type="checkbox"/> Sole Owner	<input checked="" type="checkbox"/> Corporation	<input type="checkbox"/> Limited Liability Company (LLC)	<input type="checkbox"/> Limited Liability Partnership (LLP)	<input type="checkbox"/> Unincorporated Business Trust
<input type="checkbox"/> Spouses' Co-ownership	<input type="checkbox"/> Registered Domestic Partnership	<input type="checkbox"/> General Partnership	<input type="checkbox"/> Limited Partnership	<input type="checkbox"/> Other: (describe)
1. Name of Sole Owner, Corporation, Partnership, Institute, Other. Life Technologies Corporation				
2. Business Trade Name ("Doing Business As," if any) None				
3. Business Address (physical location of your business: street number and name, city, state, country, zip or postal code) 5791 Van Allen Way, Carlsbad, California 92008, USA				
4. Mailing Address (street name and number, P.O. box, city, state, country, zip or postal code, if different from 3) The Same as Above				
5. Business Website Address(es): http://www.lifetechnologies.com				
6. Name of Owner, Responsible Corporate Officer, Partner, Other. Sang-Tae Kim				
7. Contact Information for Person in 6 above.				
Name: Sang-Tae Kim		Title: Manager, Design-for-Environment		
Business Telephone: 650-554-2798		Email: sang-tae.kim@lifetech.com		
8. Number of Employees (California employees). 2908				
9. NAICS Code(s) for this business:		Primary: 325413	Other:	Other:
10. Nano Chemical Business Type: (check applicable)		<input checked="" type="checkbox"/> Manufacturer	<input checked="" type="checkbox"/> Importer	<input checked="" type="checkbox"/> Researcher

SECTION C: CERTIFICATION (FOR THIS COMPLETE SUBMITTAL)		
I am fully authorized to prepare and submit this information, as a formal response to the request pursuant to Health and Safety Code section 57019(d)(1), and certify the information and statements made herein, and in the attachments, are correct to the best of my knowledge and belief.		
Name: (type or print) Sang-Tae Kim	Signature: 	Date: December 15, 2011

SECTION D: NANOMATERIAL CHEMICAL AND PHYSICAL PROPERTIES (Attach additional pages as needed)		
PRODUCT / PRODUCTION INFORMATION		
NANO CHEMICAL NAME: Qtracker® non-targeted quantum dots		
COMMERCIAL NAME(S): Qtracker® 565 non-targeted quantum dots; Qtracker® 655 non-targeted quantum dots; Qtracker® 705 non-targeted quantum dots; Qtracker® 800 non-targeted quantum dots		
ANNUAL PRODUCTION VOLUME: Total annual production is 0.038 gram. Quantity shipped to California is 0.009 gram.		
PRODUCTION METHOD(S): Core and core-shell nanoparticles are produced using common colloidal synthesis techniques. Some examples may be found in the following patents: 6,322,901; 6,815,064; 7,147,712; 7,695,642. Some examples of methods for applying the amphiphilic coating to these particles to render them water soluble may be found in the following patent 6,649,138.		
IDENTIFICATION OF THE SUPPLIER(S): Life Technologies is the producer and supplier of these products.		
PARAMETER	VALUE / RANGE	NAME OF ANALYTICAL METHOD(S)
PHYSICAL PROPERTIES		
SHAPE (MORPHOLOGY)	The morphology of a nanoparticle is most commonly measured by transmission electron microscopy (TEM) since it is the only analytical technique with resolution sufficient to resolve the fine features of a nanoparticle. This technique is limited, however, since it is most sensitive to electron dense elements of the nanoparticle like cadmium, zinc and selenium and virtually insensitive to lighter elements like carbon, hydrogen, oxygen and nitrogen. This means that shape and morphology information is not available for nanoparticles that comprise organic coatings. In other words, TEM can only give you information about the nanocrystal within a nanoparticle. TEM is further limited by the fact that the data acquired is only a two dimensional projection of the three dimensional shape. Therefore to calculate the volume or surface area, a three dimensional shape must be assumed. The size of the nanoparticle (nanocrystal and organic ligands) can be measured by size exclusion chromatography (SEC) but this technique does not have the resolution to provide morphology information.	
DENSITY	The density of these materials has not been measured	
SURFACE AREA	Since we cannot measure the morphology of Qtracker® non-targeted quantum dot nanoparticles, we cannot calculate the surface area. If we approximate the morphology as a sphere and use the SEC sizing data, we can calculate a spherical surface area.	
PARTICLE SIZE DISTRIBUTION	Air	To the best of our knowledge, no technique is currently available
	Liquid	Dynamic light scattering can give particle size distribution data, however, several complications exist in interpreting the data. Some of those caveats include, (1) since quantum dots have broad absorbance, any color that emits at longer wavelengths than the laser will absorb some of the laser light and make interpretation of the data nearly impossible, (2) large particles scatter much more efficiently than smaller particles making detection of small particle populations difficult.
	Solid/Powder	To the best of our knowledge, no technique is currently available
OTHER (SPECIFY)		
CHEMICAL PROPERTIES		
CHEMICAL COMPOSITION	The inorganic portion of the nanoparticles (nanocrystal) is composed of cadmium, selenium, zinc and sulfur. Two of our nanocrystal products (Qdot 705 and 800) additionally	The chemical composition of this polymer is best

		contain tellurium. The exact composition of the ligand shell is unknown but NMR has revealed that it is mostly composed of tetradecylphosphonic acid (TDPA) and/or other phosphorus-containing species. The polymer coating is an amphiphilic molecule that is associated with the nanoparticle and provides water solubility. The polyethylene glycol (PEG) coating is attached to the polymer coating through amide bonds created by reacting amine-functional PEG molecules with carbodiimide (e.g., 1-Ethyl-3-[3-dimethylaminopropyl]carbodiimide hydrochloride) activated carboxylate groups on the polymer coating.	described in Patent Number 6,649,138
SURFACE MODIFICATION (COATING, FUNCTIONALIZATION)		The outer surface contains an amphiphilic polymer and polyethylene glycol.	The process of applying this polymer to the nanoparticles is best described in patent number 6,649,138.
PURITY		Purity is essential for our products. We have most routinely use SEC to detect and measure impurities. Some of those impurities include aggregated nanoparticles, free (unbound) amphiphilic polymer, and other nanoparticle impurities.	
SURFACE CHARGE		We routinely perform gel electrophoresis to confirm the charge of a particle but we do not quantitate it in terms of charge density.	
DISPERSION	Air	We do not handle air dispersions in our operations or R&D	
	Liquid	Presence of aggregated particles is routinely measured by SEC chromatography. In fact, all of our products and water soluble intermediates have specifications around the percentage of these soluble aggregates present in the solution.	
	Solid	We do not handle the materials in the solid form, but as a liquid dispersion.	
IDENTIFYING AND DETERMINING CONCENTRATION OF NANO CHEMICAL, ITS METABOLITES, AND DEGRADATION PRODUCTS IN SPECIFIED MATRICES (Water, Air, Soil, Sediment, Sludge, Chemical Waste, Fish, Blood, Adipose Tissue, Urine, Other)		Determining the exact concentration of nanoparticles in any matrix is difficult because routine nanoparticle counting techniques do not currently exist. The most common method for determining the concentration of quantum dots is to measure the optical absorbance in solution at a concentration where Beer's law is operative and calculate the concentration using an estimated extinction coefficient for the material.	A example of a common technique for estimating the extinction coefficient for quantum dot can be found in this reference (Chem. Mater. 2003, 15, 2854-2860)
SOLUBILITY	Water Solubility	Soluble/miscible in water. These products are sold at a concentration of 2 micromolar which is in the range of 0.125 mg/mL to 2 mg/mL depending on the color.	
	Solubility in Organic Solvent	Not soluble/miscible in organic solvent	
N-OCTANOL-WATER PARTITION COEFFICIENT		We have not measured this parameter.	
STABILITY AND REACTIVITY	Flammability	These nanoparticle products are sold as dilute (2 µM or approximately 0.125 mg to 2 mg/mL) aqueous solutions and are therefore classified with a HMIS flammability rating of 0 (same as water).	
	Explosiveness	These products do not pose an explosion hazard. This conclusion is partially based on thermogravimetric analysis (TGA) of our ITK organic quantum dots. TGA shows that no weight loss occurs until about 300 °C. At around 300	

		°C the particles lose about 10 - 20 % of their mass. This temperature coincides with the boiling point of the organic ligands used in the synthesis of quantum dots. No other weight loss is observed up to a temperature of 650 °C.	
	Oxidizing Properties	These products are not strong oxidizing agents.	
	Oxidation Reduction Potential	These products are not strong reducing agents.	
	Storage Stability and Reactivity (Container Material)	These products are stable in a variety of container materials including, glass and plastic. The product is packaged and shipped in polypropylene vials.	
	Stability to Thermal, Sunlight, and Metal(s)	These products are stable, meaning that they will work for their intended purpose, to multiple rounds of freezing and thawing and moderately high temperatures (0 °C to 37 °C). These products are stable and will work for their intended purpose with moderate sunlight exposure. Some metals will quench the florescence from these particles. Particularly copper (II) and iron (III).	Reference - Cytometry Part A, 79A: 84 89, 2011

SECTION E: Provide a copy of your Globally Harmonized System (GHS) Safety Data Sheet (SDS), if you have prepared one.
 Attached is current SDS/Material Safety Data Sheet (MSDS). See Attachment I

SECTION F: For each nanomaterial you produce or import, describe the analytical test method(s) that you use, or plan to use, to sample, prepare, and analyze a specific matrix to determine the identity and concentration of each specified nanomaterial. Use a separate page to describe the procedure for each, individual matrix, which must include water, air, soil, sediment, sludge, chemical waste, fish, blood, adipose tissue, and urine. Include the information requested in Section D above.

Life Technologies' *Medical Surveillance and Monitoring Plan* requires a bi-annual monitoring of blood and urine samples as well as an annual physical examination of employees who are involved in manufacturing of quantum dots. No cadmium was detectable from either blood or urine samples, when analyzed with the use of Inductively Coupled Plasma/Mass Spectrometry (ICP-MS) (see <http://www.aruplab.com/guides/ug/tests/0025040.jsp> for detailed information on sampling and analysis methodology).

We have not determined the identity and concentration of Qtracker® non-targeted quantum dot nanoparticles in environmental matrix including air, soil, sediment, sludge, chemical waste, fish, and adipose tissue.

ATTACHMENT 1
MATERIAL SAFETY DATA SHEET
(Sample)



SAFETY DATA SHEET

1. Identification of the substance/mixture and of the company/undertaking**Identification of the substance/preparation**

Product code Q21021MP
Product name Qtracker® 655 non-targeted quantum dots

Company/Undertaking Identification

Life Technologies
5791 VAN ALLEN WAY
PO BOX 6482
CARLSBAD, CA 92008
+1 760 603 7200

INVITROGEN CORPORATION
5250 MAINWAY DRIVE
BURLINGTON, ONT
CANADA L7L 6A4
800/263-6236

24 hour Emergency Response (Transport): 866-536-0631
301-431-8585
Outside of the U.S. +1-301-431-8585

For research use only. Not intended for human or animal diagnostic or therapeutic uses.

Revision Date 29-Nov-2011
Product code Q21021MP

Page 1 / 8
Product name Qtracker® 655 non-targeted quantum dots

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2. Hazards identification

GHS - Classification

Signal Word
not hazardous

Health Hazard
not hazardous

Physical Hazards
not hazardous

**Principle Routes of Exposure/
Potential Health effects**

Eyes	May cause eye irritation with susceptible persons.
Skin	May cause skin irritation in susceptible persons.
Inhalation	May be harmful by inhalation.
Ingestion	May be harmful if swallowed.

Specific effects

Carcinogenic effects	none.
Mutagenic effects	none.
Reproductive toxicity	none.
Sensitization	none

Target Organ Effects No known effects under normal use conditions

HMIS

Health	0
Flammability	0
Reactivity	0

3. Composition/information on ingredients

The product contains no substances which at their given concentration, are considered to be hazardous to health. We recommend handling all chemicals with caution.

4. First aid measures

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Product code Q21021MP

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Product name Qtracker® 055 non-targeted quantum dots

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Skin contact	Rinse with plenty of water. If symptoms arise, call a physician.
Eye contact	Rinse immediately with plenty of water, also under the eyelids, for at least 15 minutes. If symptoms persist, call a physician.
Ingestion	Never give anything by mouth to an unconscious person. If symptoms persist, call a physician. Do not induce vomiting without medical advice.
Inhalation	Move to fresh air. If symptoms persist, call a physician. If not breathing, give artificial respiration.
Notes to physician	Treat symptomatically.

5. Fire-fighting measures

Suitable extinguishing media	Water spray. Carbon dioxide (CO ₂). Foam. Dry chemical.
Special protective equipment for firefighters	Wear self-contained breathing apparatus and protective suit.

6. Accidental release measures

Personal precautions	Use personal protective equipment.
Methods for cleaning up	Soak up with inert absorbent material.

Environmental precautions

Prevent further leakage or spillage if safe to do so.

See Section 12 for additional information.

7. Handling and storage

Handling	Always wear recommended Personal Protective Equipment. No special handling advice required.
Storage	Keep in a dry, cool and well-ventilated place.

8. Exposure controls/personal protection

Exposure limits

At this time, the limited evidence available suggests caution when potential exposures to nanoparticles may occur. Due to the limited information about health risks from nanomaterials, it is prudent to take steps for minimizing worker exposures. Research is still needed to understand the impact of nanotechnology on health, and to determine appropriate exposure monitoring and control strategies.

Engineering measures	Ensure adequate ventilation, especially in confined areas.
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Personal protective equipment

Respiratory protection	In case of insufficient ventilation wear suitable respiratory equipment.
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Hand protection	Impervious gloves.
Eye protection	Safety glasses with side-shields.
Skin and body protection.	Lightweight protective clothing.
Hygiene measures	Handle in accordance with good industrial hygiene and safety practice.

Revision Date 28-Nov-2011
Product code Q21021MP

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Product name Qtracker® 655 non-targeted quantum dots

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Environmental exposure controls Prevent product from entering drains.

9. Physical and chemical properties

General Information

Form	suspension	
Appearance	liquid	
Odor	No information available	
Boiling Point/Range	°C no data available	*F no data available
Melting point/range	°C no data available	*F no data available
Flash point	°C no data available	*F no data available
Autoignition temperature	°C no data available	*F no data available
Oxidizing properties	No information available.	
Water solubility	soluble	
pH VALUE	8.3	

10. Stability and reactivity

Stability	Stable under normal conditions.
Materials to avoid	No dangerous reaction known under conditions of normal use.
Hazardous decomposition products	None under normal use
polymerization	Hazardous polymerisation does not occur.

11. Toxicological information

Acute toxicity

At this time, the limited evidence available suggests caution when potential exposures to nanoparticles may occur. Due to the limited information about health risks from nanomaterials, it is prudent to take steps for minimizing worker exposures. Occupational health risks associated with manufacturing and using nanomaterials are not yet clearly understood. Studies have indicated that low solubility nanoparticles are more toxic than larger particles on a mass for mass basis. There are strong indications that particle surface area and surface chemistry are responsible for observed responses in cell cultures and animals. There are indications that nanoparticles can penetrate through the skin or move from the respiratory system to other organs.

Principle Routes of Exposure/

Potential Health effects

Eyes	May cause eye irritation with susceptible persons.
Skin	May cause skin irritation in susceptible persons.
Inhalation	May be harmful by inhalation.
Ingestion	May be harmful if swallowed.
Carcinogenic effects	none
Mutagenic effects	none
Reproductive toxicity	none
Sensitization	none
Target Organ Effects	No known effects under normal use conditions

Revision Date 29-Nov-2011
 Product code Q21021MP

Page 4 / 6
 Product name Qtracker® 655 non-targeted quantum dots

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12. Ecological information

Ecotoxicity effects	No information available.
Mobility	No information available.
Biodegradation	Inherently biodegradable
Bioaccumulation	Does not bioaccumulate.

13. Disposal considerations

Dispose of in accordance with local regulations.

14. Transport information

IATA

Proper shipping name	Not classified as dangerous in the meaning of transport regulations
Hazard class	none
Subsidiary Class	none
Packing group	none
UN-No	None

15. Regulatory information

U.S. Federal Regulations

SARA 313

This product contains the following toxic chemical(s) subject to the notification requirements of section 313 of Title III of the Superfund Amendments and Reauthorization Act of 1986. This law requires certain manufacturers to report on annual emissions of specified chemicals and chemical categories. Please note that if you repackage, or otherwise redistribute, this product to industrial customers, a notice similar to this one should be sent to those customers:

Clean Air Act, Section 112 Hazardous Air Pollutants (HAPs) (see 40 CFR 61)

This product does not contain HAPs.

U.S. State Regulations

California Proposition 65

This product does not contain chemicals listed under Proposition 65

WHMIS hazard class:

Non-controlled

This product has been classified according to the hazard criteria of the CPR and the MSDS contains all of the information required by the CPR

16. Other information

Reason for Revision (M)SDS sections updated.

Revision Date 20-Nov-2011
Product code Q21021MP

Page 5 / 6
Product name Qtracker® 855 non-targeted quantum dots

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For research use only. Not intended for human or animal diagnostic or therapeutic uses.

References

- National Institute for Occupational Safety and Health (NIOSH), U.S., 2010:
<http://www.cdc.gov/niosh/topics/nanotech/>
- National Institute for Occupational Safety and Health (NIOSH), U.S., 2009:
<http://www.cdc.gov/niosh/docs/2009-125/pdfs/2009-125.pdf>

The above information was acquired by diligent search and/or investigation and the recommendations are based on prudent application of professional judgment. The information shall not be taken as being all inclusive and is to be used only as a guide. All materials and mixtures may present unknown hazards and should be used with caution. Since the Company cannot control the actual methods, volumes, or conditions of use, the Company shall not be held liable for any damages or losses resulting from the handling or from contact with the product as described herein. THE INFORMATION IN THIS MSDS DOES NOT CONSTITUTE A WARRANTY, EXPRESSED OR IMPLIED, INCLUDING ANY IMPLIED WARRANTY OF MERCHANTABILITY OR FITNESS FOR ANY PARTICULAR PURPOSE.

End of Safety Data Sheet

Revision Date 20-Nov-2011
Product code Q21021MP

Page 6 / 6
Product name Qtracker® 055 non-targeted quantum dots

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STATE OF CALIFORNIA
Department of Toxic Substances Control

Health and Safety Code Section 57019 Chemical Information Call-in Information
For Nanometals, Nanometal Oxides, and Quantum Dots
December 2010

This enclosure is provided for your convenience. You may provide the requested information in writing, and attaching any supplementary materials or explanatory information, in letter or report form.

SECTION A: CHEMICAL(S) (Check each one which applies for your company)		
<input type="checkbox"/> Nano Silver	<input type="checkbox"/> Nano Titanium Dioxide	<input type="checkbox"/> Nano Cerium Oxide
<input type="checkbox"/> Nano Zero Valent Iron	<input type="checkbox"/> Nano Zinc Oxide	<input checked="" type="checkbox"/> Quantum Dot(s)

SECTION B: BUSINESS IDENTIFICATION INFORMATION (check one and complete 1 – 10)				
<input type="checkbox"/> Sole Owner	<input checked="" type="checkbox"/> Corporation	<input type="checkbox"/> Limited Liability Company (LLC)	<input type="checkbox"/> Limited Liability Partnership (LLP)	<input type="checkbox"/> Unincorporated Business Trust
<input type="checkbox"/> Spouses' Co-ownership	<input type="checkbox"/> Registered Domestic Partnership	<input type="checkbox"/> General Partnership	<input type="checkbox"/> Limited Partnership	<input type="checkbox"/> Other: (describe)
1. Name of Sole Owner, Corporation, Partnership, Institute, Other. Life Technologies Corporation				
2. Business Trade Name ("Doing Business As," if any) None				
3. Business Address (physical location of your business: street number and name, city, state, country, zip or postal code) 5791 Van Allen Way, Carlsbad, California 92008, USA				
4. Mailing Address (street name and number, P.O. box, city, state, country, zip or postal code, if different from 3) The Same as Above				
5. Business Website Address(es): http://www.lifetechnologies.com				
6. Name of Owner, Responsible Corporate Officer, Partner, Other. Sang-Tae Kim				
7. Contact Information for Person in 6 above.				
Name: Sang-Tae Kim		Title: Manager, Design-for-Environment/EHS		
Business Telephone: 650-554-2798		Email: sang-tae.kim@lifetech.com		
8. Number of Employees (California employees). 2908				
9. NAICS Code(s) for this business:		Primary: 325413	Other:	Other:
10. Nano Chemical Business Type: (check applicable)		<input checked="" type="checkbox"/> Manufacturer	<input checked="" type="checkbox"/> Importer	<input checked="" type="checkbox"/> Researcher

SECTION C: CERTIFICATION (FOR THIS COMPLETE SUBMITTAL)		
I am fully authorized to prepare and submit this information, as a formal response to the request pursuant to Health and Safety Code section 57019(d)(1), and certify the information and statements made herein, and in the attachments, are correct to the best of my knowledge and belief.		
Name: (type or print) Sang-Tae Kim	Signature: 	Date: December 15, 2011

SECTION D: NANOMATERIAL CHEMICAL AND PHYSICAL PROPERTIES (Attach additional pages as needed)		
PRODUCT / PRODUCTION INFORMATION		
NANO CHEMICAL NAME: Qdot® dipeptide quantum dots (custom synthesis)		
COMMERCIAL NAME(S): Qdot® 655 dipeptide quantum dots (custom synthesis)		
ANNUAL PRODUCTION VOLUME: Total annual production is 0.039 grams. Quantity shipped to California is 0 gram.		
PRODUCTION METHOD(S): Core and core-shell nanoparticles are produced using common colloidal synthesis techniques. Some examples may be found in the following patents: 6,322,901; 6,815,064; 7,147,712; 7,695,642. Some examples of methods for applying the amphiphilic coating to these particles to render them water soluble may be found in the following patent 6,649,138.		
IDENTIFICATION OF THE SUPPLIER(S): Life Technologies is the producer and supplier of these products.		
PARAMETER	VALUE / RANGE	NAME OF ANALYTICAL METHOD(S)
PHYSICAL PROPERTIES		
SHAPE (MORPHOLOGY)	The morphology of a nanoparticle is most commonly measured by transmission electron microscopy (TEM) since it is the only analytical technique with resolution sufficient to resolve the fine features of a nanoparticle. This technique is limited, however, since it is most sensitive to electron dense elements of the nanoparticle like cadmium, zinc and selenium and virtually insensitive to lighter elements like carbon, hydrogen, oxygen and nitrogen. This means that shape and morphology information is not available for nanoparticles that comprise organic coatings. In other words, TEM can only give you information about the nanocrystal within a nanoparticle. TEM is further limited by the fact that the data acquired is only a two dimensional projection of the three dimensional shape. Therefore to calculate the volume or surface area, a three dimensional shape must be assumed. The size of the nanoparticle (nanocrystal and organic ligands) can be measured by size exclusion chromatography (SEC) but this technique does not have the resolution to provide morphology information.	
DENSITY	The density of these materials has not been measured	
SURFACE AREA	Since we cannot measure the morphology of Qdot® dipeptide quantum dot (custom synthesis) nanoparticles, we cannot calculate the surface area. If we approximate the morphology as a sphere and use the SEC sizing data, we can calculate a spherical surface area.	
PARTICLE SIZE DISTRIBUTION	Air	To the best of our knowledge, no technique is currently available
	Liquid	Dynamic light scattering can give particle size distribution data, however, several complications exist in interpreting the data. Some of those caveats include, (1) since quantum dots have broad absorbance, any color that emits at longer wavelengths than the laser will absorb some of the laser light and make interpretation of the data nearly impossible, (2) large particles scatter much more efficiently than smaller particles making detection of small particle populations difficult.
	Solid/ Powder	To the best of our knowledge, no technique is currently available
OTHER (SPECIFY)		
CHEMICAL PROPERTIES		
CHEMICAL COMPOSITION	The inorganic portion of the nanoparticles (nanocrystal) is composed of cadmium, selenium, zinc and sulfur. The exact composition of the ligand shell is unknown but NMR has revealed that it is mostly composed of	The chemical composition of this dipeptide coating is best described in

Qdot® dipeptide quantum dots (custom synthesis)

		tetradecylphosphonic acid (TDPA) and/or other phosphorus-containing species. The hydrophilic coating is composed of two dipeptides (his-leu and gly-his), polyethylene glycol molecules, Tris(hydroxymethyl)phosphine (THP) and 2-aminobenzophenone. Both THP and 2-aminobenzophenone are used as crosslinkers.	Patent Number 7,368,086
SURFACE MODIFICATION (COATING, FUNCTIONALIZATION)		The outer surface contains dipeptides, and polyethylene glycol	The process of applying this polymer to the nanoparticles is best described in patent number 7,368,086.
PURITY		Purity is essential for our products. We have most routinely use SEC to detect and measure impurities. Some of those impurities include aggregated nanoparticles, free (unbound) amphiphilic polymer, and other nanoparticle impurities.	
SURFACE CHARGE		We routinely perform gel electrophoresis to confirm the charge of a particle but we do not quantitate it in terms of charge density.	
DISPERSION	Air	We do not handle air dispersions in our operations or R&D	
	Liquid	Presence of aggregated particles is routinely measured by SEC chromatography. In fact, all of our products and water soluble intermediates have specifications around the percentage of these soluble aggregates present in the solution.	
	Solid	We do not handle the materials in the solid form, but as a liquid dispersion.	
IDENTIFYING AND DETERMINING CONCENTRATION OF NANO CHEMICAL, ITS METABOLITES, AND DEGRADATION PRODUCTS IN SPECIFIED MATRICES (Water, Air, Soil, Sediment, Sludge, Chemical Waste, Fish, Blood, Adipose Tissue, Urine, Other)		Determining the exact concentration of nanoparticles in any matrix is difficult because routine nanoparticle counting techniques do not currently exist. The most common method for determining the concentration of quantum dots is to measure the optical absorbance in solution at a concentration where Beer's law is operative and calculate the concentration using an estimated extinction coefficient for the material.	A example of a common technique for estimating the extinction coefficient for quantum dot can be found in this reference (Chem. Mater. 2003, 15, 2854-2860)
SOLUBILITY	Water Solubility	Soluble/miscible in water. These products are sold at a concentration of 4 micromolar which is in the range of 0.25 mg/mL to 4 mg/mL depending on the color.	
	Solubility in Organic Solvent	Not soluble/miscible in organic solvent	
N-OCTANOL-WATER PARTITION COEFFICIENT		We have not measured this parameter.	
STABILITY AND REACTIVITY	Flammability	These nanoparticle products are sold as dilute (4 µM or approximately 0.25 mg to 4 mg/mL) aqueous solutions and are therefore classified with a HMIS flammability rating of 0 (same as water).	
	Explosiveness	These products do not pose an explosion hazard. This conclusion is partially based on thermogravimetric analysis (TGA) of our ITK organic quantum dots. TGA shows that no weight loss occurs until about 300 °C. At around 300 °C the particles lose about 10 - 20 % of their mass. This temperature coincides with the boiling point of the organic ligands used in the synthesis of quantum dots. No other weight loss is observed up to a temperature of 650 °C.	
	Oxidizing	These products are not strong oxidizing agents.	

Qdot® dipeptide quantum dots (custom synthesis)

	Properties		
	Oxidation Reduction Potential	These products are not strong reducing agents.	
	Storage Stability and Reactivity (Container Material)	These products are stable in a variety of container materials including, glass and plastic. The product is packaged and shipped in polypropylene vials.	
	Stability to Thermal, Sunlight, and Metal(s)	These products are stable, meaning that they will work for their intended purpose, to multiple rounds of freezing and thawing and moderately high temperatures (0 °C to 37 °C). These products are stable and will work for their intended purpose with moderate sunlight exposure. Some metals will quench the florescence from these particles. Particularly copper (II) and iron (III).	Reference - Cytometry Part A, 79A: 84 89, 2011

SECTION E: Provide a copy of your Globally Harmonized System (GHS) Safety Data Sheet (SDS), if you have prepared one.

Attached is current SDS/Material Safety Data Sheet (MSDS). See Attachment I

SECTION F: For each nanomaterial you produce or import, describe the analytical test method(s) that you use, or plan to use, to sample, prepare, and analyze a specific matrix to determine the identity and concentration of each specified nanomaterial. Use a separate page to describe the procedure for each, individual matrix, which must include water, air, soil, sediment, sludge, chemical waste, fish, blood, adipose tissue, and urine. Include the information requested in Section D above.

Life Technologies' *Medical Surveillance and Monitoring Plan* requires a bi-annual monitoring of blood and urine samples as well as an annual physical examination of employees who are involved in manufacturing of quantum dots. No cadmium was detectable from either blood or urine samples, when analyzed with the use of Inductively Coupled Plasma/Mass Spectrometry (ICP-MS) (see <http://www.aruplab.com/guides/ug/tests/0025040.jsp> for detailed information on sampling and analysis methodology).

We have not determined the identity and concentration of Qdot® dipeptide quantum dot (custom synthesis) nanoparticles in environmental matrix including air, soil, sediment, sludge, chemical waste, fish, and adipose tissue.

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ATTACHMENT 1
MATERIAL SAFETY DATA SHEET



SAFETY DATA SHEET

1. Identification of the substance/mixture and of the company/undertaking

Identification of the substance/preparation

Product code C47013
Product name CUSTOM SYNTHESIS Qdot® 655 dipeptide quantum dots *commercial use*

Company/Undertaking Identification

Life Technologies
5791 VAN ALLEN WAY
PO BOX 6482
CARLSBAD, CA 92008
+1 760 603 7200

INVITROGEN CORPORATION
5250 MAINWAY DRIVE
BURLINGTON, ONT
CANADA L7L 6A4
800/263-6236

24 hour Emergency Response (Transport): 866-536-0631
301-431-8585
Outside of the U.S. +1-301-431-8585

For research use only. Not intended for human or animal diagnostic or therapeutic uses.

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2. Hazards identification

GHS - Classification

Signal Word
not hazardous

Health Hazard
not hazardous

Physical Hazards
not hazardous

Principle Routes of Exposure/ Potential Health effects

Eyes	May cause eye irritation with susceptible persons.
Skin	May cause skin irritation in susceptible persons.
Inhalation	May be harmful by inhalation.
Ingestion	May be harmful if swallowed.

Specific effects

Carcinogenic effects	none.
Mutagenic effects	none.
Reproductive toxicity	none.
Sensitization	none.

Target Organ Effects No known effects under normal use conditions

HMIS

Health	0
Flammability	0
Reactivity	0

3. Composition/information on ingredients

The product contains no substances which at their given concentration, are considered to be hazardous to health. We recommend handling all chemicals with caution.

4. First aid measures

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Skin contact	Rinse with plenty of water. If symptoms arise, call a physician.
Eye contact	Rinse immediately with plenty of water, also under the eyelids, for at least 15 minutes. If symptoms persist, call a physician.
Ingestion	Never give anything by mouth to an unconscious person. If symptoms persist, call a physician. Do not induce vomiting without medical advice.
Inhalation	Move to fresh air. If symptoms persist, call a physician. If not breathing, give artificial respiration.
Notes to physician	Treat symptomatically.

5. Fire-fighting measures

Suitable extinguishing media	Water spray. Carbon dioxide (CO ₂). Foam. Dry chemical.
Special protective equipment for firefighters	Wear self-contained breathing apparatus and protective suit.

6. Accidental release measures

Personal precautions	Use personal protective equipment.
Methods for cleaning up	Soak up with inert absorbent material.

Environmental precautions

Prevent further leakage or spillage if safe to do so.

See Section 12 for additional information.

7. Handling and storage

Handling	Always wear recommended Personal Protective Equipment. No special handling advice required.
Storage	Keep in a dry, cool and well-ventilated place.

8. Exposure controls/personal protection

Exposure limits

At this time, the limited evidence available suggests caution when potential exposures to nanoparticles may occur. Due to the limited information about health risks from nanomaterials, it is prudent to take steps for minimizing worker exposures. Research is still needed to understand the impact of nanotechnology on health, and to determine appropriate exposure monitoring and control strategies.

Engineering measures	Ensure adequate ventilation, especially in confined areas.
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Personal protective equipment

Respiratory protection	In case of insufficient ventilation wear suitable respiratory equipment.
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Hand protection	Impervious gloves.
Eye protection	Safety glasses with side-shields.
Skin and body protection.	Lightweight protective clothing.
Hygiene measures	Handle in accordance with good industrial hygiene and safety practice.

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Environmental exposure controls Prevent product from entering drains.

9. Physical and chemical properties

General Information

Form	suspension	
Appearance	liquid	
Odor	No information available	
Boiling Point/Range	°C no data available	°F no data available
Melting point/range	°C no data available	°F no data available
Flash point	°C no data available	°F no data available
Autoignition temperature	°C no data available	°F no data available
Oxidizing properties	No information available.	
Water solubility	soluble	
pH VALUE	8.3	

10. Stability and reactivity

Stability	Stable under normal conditions.
Materials to avoid	No dangerous reaction known under conditions of normal use.
Hazardous decomposition products	None under normal use
polymerization	Hazardous polymerisation does not occur.

11. Toxicological information

Acute toxicity

At this time, the limited evidence available suggests caution when potential exposures to nanoparticles may occur. Due to the limited information about health risks from nanomaterials, it is prudent to take steps for minimizing worker exposures. Occupational health risks associated with manufacturing and using nanomaterials are not yet clearly understood. Studies have indicated that low solubility nanoparticles are more toxic than larger particles on a mass for mass basis. There are strong indications that particle surface area and surface chemistry are responsible for observed responses in cell cultures and animals. There are indications that nanoparticles can penetrate through the skin or move from the respiratory system to other organs.

Principle Routes of Exposure/

Potential Health effects

Eyes	May cause eye irritation with susceptible persons.
Skin	May cause skin irritation in susceptible persons.
Inhalation	May be harmful by inhalation.
Ingestion	May be harmful if swallowed.
Carcinogenic effects	none
Mutagenic effects	none
Reproductive toxicity	none
Sensitization	none

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Target Organ Effects No known effects under normal use conditions

12. Ecological information

Ecotoxicity effects	No information available.
Mobility	No information available.
Biodegradation	Inherently biodegradable
Bioaccumulation	Does not bioaccumulate.

13. Disposal considerations

Dispose of in accordance with local regulations.

14. Transport information

IATA

Proper shipping name	Not classified as dangerous in the meaning of transport regulations
Hazard class	none
Subsidiary Class	none
Packing group	none
UN-No	None

15. Regulatory information

U.S. Federal Regulations

SARA 313

This product contains the following toxic chemical(s) subject to the notification requirements of section 313 of Title III of the Superfund Amendments and Reauthorization Act of 1986. This law requires certain manufacturers to report on annual emissions of specified chemicals and chemical categories. Please note that if you repack, or otherwise redistribute, this product to industrial customers, a notice similar to this one should be sent to those customers:

Clean Air Act, Section 112 Hazardous Air Pollutants (HAPs) (see 40 CFR 61)

This product does not contain HAPs.

U.S. State Regulations

California Proposition 65

This product does not contain chemicals listed under Proposition 65

WHMIS hazard class:

Non-controlled

This product has been classified according to the hazard criteria of the GPR and the MSDS contains all of the information required by the GPR

16. Other information

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Reason for Revision (M)SDS sections updated.

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References

- National Institute for Occupational Safety and Health (NIOSH), U.S., 2010:
<http://www.cdc.gov/niosh/topics/nanotech/>
- National Institute for Occupational Safety and Health (NIOSH), U.S., 2009:
<http://www.cdc.gov/niosh/docs/2009-125/pdfs/2009-125.pdf>

The above information was acquired by diligent search and/or investigation and the recommendations are based on prudent application of professional judgment. The information shall not be taken as being all inclusive and is to be used only as a guide. All materials and mixtures may present unknown hazards and should be used with caution. Since the Company cannot control the actual methods, volumes, or conditions of use, the Company shall not be held liable for any damages or losses resulting from the handling or from contact with the product as described herein. THE INFORMATION IN THIS MSDS DOES NOT CONSTITUTE A WARRENTY, EXPRESSED OR IMPLIED, INCLUDING ANY IMPLIED WARRANTY OF MERCHANTABILITY OR FITNESS FOR ANY PARTICULAR PUPOSE.

End of Safety Data Sheet

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