Sun Innovations, Inc.
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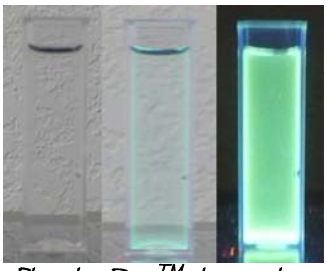
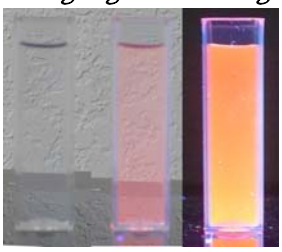
PHOSPHOR DOTS™

Sun Innovation's Phosphor Dots™ are a new alternative to organic dyes and quantum dots. Phosphor Dots combine the best features of both, having a lifetime comparable to quantum dots, while being a non-toxic like an organic dye. Our inorganic Phosphor Dots:

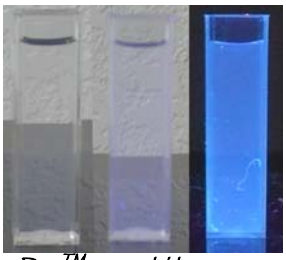
- Higher color purity than quantum dots
- No toxic cadmium or lead
- Compliant with European RoHS and other regulations which prohibit cadmium & lead
- Lower cost than quantum dots
- Longer life than organic dyes and many quantum dots
- Longer life, more colors than zinc selenide quantum dots
- Comparable absorption: emission efficiency
- Many Phosphor Dots have quantum yield equivalent to quantum dots
- Nano-phosphors are available in aqueous dispersions, whereas quantum dots usually require an organic solvent



Phosphor Dots™ shown without excitation on left, with excitation in different amient lighting at center and right



Phosphor Dots™ can be used in traditional quantum dot applications, and are particularly suited to biomedical applications since they lack the inherent toxicity of the quantum dots.



Phosphor Dots™ are available in a variety of colors, and have single or multiple peak emissions instead of band emissions, so they make more unique markers than quantum dots!

Biomedical applications of quantum dots may include:

1. Microscopy and multiplexed histology
2. Flow-cytometry
3. Drug delivery
4. Photodynamic therapy
5. In vivo whole animal and clinical imaging (e.g., angiography)
6. Tissue mapping and demarcation (e.g., sentinel lymph node)
7. Real time detection of intracellular events, signaling, and bio-sensing
8. Tracking cell migration (e.g., stem cells)
9. Low cost but sensitive point-of-care detection (e.g., lateral flow)
10. Environment and bio-defense

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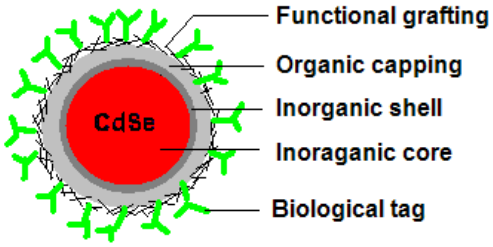
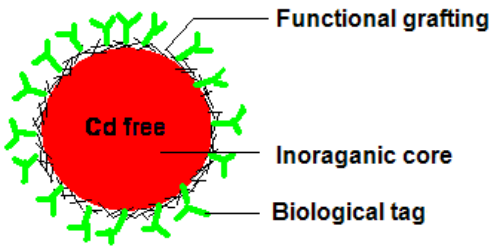
Quantum Dot Structure



Phosphor Dot Structure



Advantages of nanoparticle phosphor compared to fluorescent dyes

Conventional dye molecules impose stringent requirements on the optical systems used to make measurements. Their narrow excitation spectrum makes simultaneous excitation difficult in most cases, and their broad emission spectrum with a long tail at red wavelengths introduces spectral cross talk between different detection channels, making quantitation of the relative amounts of different probes difficult. Ideal probes for multicolor experiments should emit at spectrally resolvable energies and have a narrow, symmetric emission spectrum, and the whole group of probes should be excitable at a single wavelength. Phosphor Dots™ solve this problem by having disparate emission peaks, and exciting at the same wavelength so it's easy to get reliable data.

Two problems associated with fluorescence microscopy—cell autofluorescence in the visible spectrum (which can mask signals from labeled molecules) and the requirement of long observation times—have created a need for new probes that emit in the visible range and are more photostable than current organic fluorophores. The long fluorescence lifetime of nanoparticle phosphor-based Phosphor Dots™ enables the use of time-gated detection to separate their signal from that of shorter lived species such as background autofluorescence encountered in cells. Single Phosphor Dots™ can be observed and tracked over an extended period of time (up to a few hours) with confocal microscopy, total internal reflection microscopy, or basic wide-field epifluorescence microscopy.

	Old-Fashioned Quantum Dots	Sun Innovation's Phosphor Dots™
Toxicity	Toxic without external shell protection through gradual releasing of cadmium or lead. Could be toxic for long-term applications even being insulated by a shell.	Has no lead or cadmium
Lifetime & durability	Shell layer required to protect core from oxidization and emission quenching, increasing cost and manufacturing complexity.	No risk of oxidization since Phosphor Dots™ are an oxide, and have high emission yield without requiring complex surface treatments. Less manufacturing steps reduces number of steps in which variation, manufacturing tolerances, or defects can occur.
Solubility	Solubility in water is generally bad without additional chemical modifications to render a	Prepared in aqueous solution, so solubility is not a problem.

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	hydrophilic surface. Most biological applications are in aqueous system.	
Size vs. Color	Emission color is size dependent	Color is not size dependent. Particle size can be tailored for different biological applications with same detection technology
UV absorption	Broad UV absorption. Tunable colors emission from 400 nm to 900 nm.	Narrow UV absorption.
Excitation	Simultaneous excitation due to broad UV excitation	Simultaneous excitation due to same host UV absorption.
Synthesis	Synthesis is complicated, such that scaling up production could be difficult.	Simpler synthesis which can be easily scaled up to mass production.
Functioning	More steps such as ligand exchange are required to add functional groups.	No ligand exchange required; easy to add functionalization.

SPECIFICATIONS AND PRICING:

DESCRIPTION	EXCITE	EMISS	PURITY	AV SIZE	SIZE RANGE	DISPERSION	PICTURE &/or SSA	WEIGHT or MORPH	ITEM #	PRICE
Europium Doped Yttrium Vanadate Colloid	350 nm	620 nm	99%	10 nm	n/a	Solvent: H2O		n/a	YVE1005	$200/ml
Cerium Doped Yttrium Aluminum Garnet Colloid	350-400 nm	550 nm	99%	15 nm	2-60 nm	Solvent: 1,4-butenediol	 30 - 50 m2/g	Spherical	YAG1001	$1000/gram
Thulium Doped Yttrium Vanadate Colloid	300 nm	477 nm	n/a	254 nm	150~350 nm	<0.7mg/mL PVP		Weight 0.2mg/mL	YVT1101	$80/gram
Samarium Doped Yttrium Vanadate Colloid	300 nm	568, 607, & 650 nm	n/a	27 nm	n/a	Aqueous Colloid with Trace of Citrate		Weight 50mg/mL	YVS1001	$250/gram
Samarium Doped Yttrium Vanadate Colloid	300 nm	568, 607, & 650 nm	n/a	152 nm	100~200 nm	<0.7mg/mL PVP		Weight 0.2mg/mL	YVS1101	$80/gram
Dysprosium Doped Yttrium Vanadate Colloid	300 nm	486 & 576 nm	n/a	23 nm	n/a	Aqueous Colloid with Trace of Citrate		Weight 50mg/mL	YVD1001	$250/gram
Dysprosium Doped Yttrium Vanadate Colloid	300 nm	486 & 576 nm	n/a	172 nm	120~220 nm	<0.7mg/mL PVP		Weight 0.2mg/mL	YVD1101	$80/gram