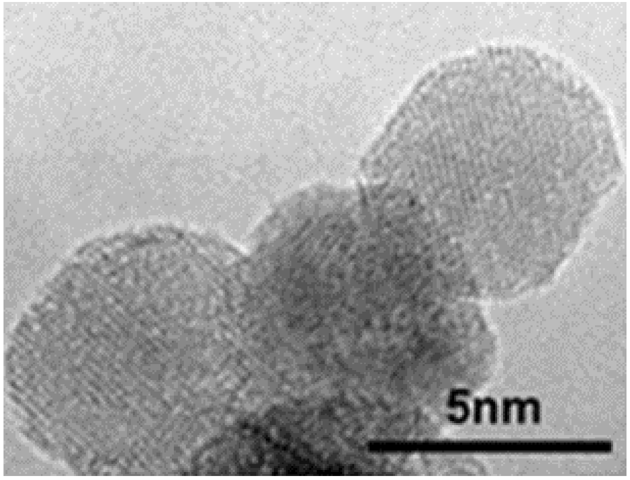
5 nm Detonation Nanodiamond Suspensions

Product Sheet

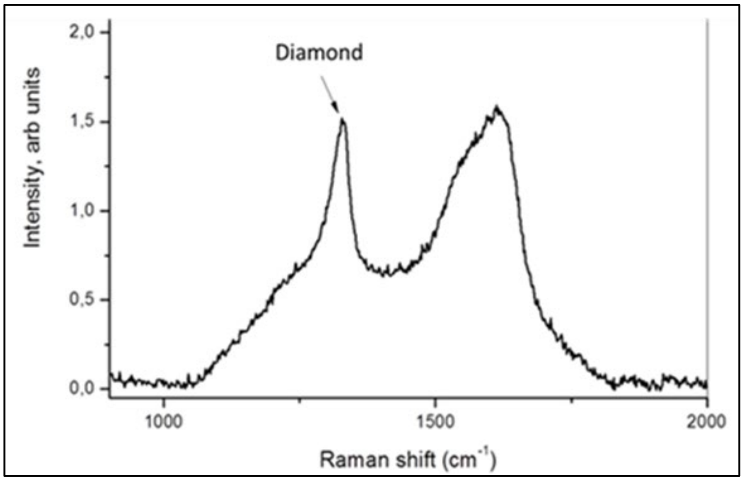
Detonation nanodiamond (DND) is produced from the carbon contained in high-energy explosives. The characteristic size of primary particles formed in the detonation process is ~ 5 nm, which can be isolated from large tight aggregates formed during synthesis and purification. Colloidal suspensions of detonation nanodiamond in both water and a variety of organic solvents have a wide range of uses, including: (1) drug delivery research, (2) nanocomposite strengthening, (3) electroplating, (4) polishing, and (5) oil and fuel additives. This brochure provides characteristics of fully deagglomerated monodispersed 5 nm nanodiamond suspensions.

Technical Characteristics

Adámas offers two primary lines of 5 nm primary particles : (1) a standard non-luminescent line, and (2) a fluorescent line which is about 10-20x brighter than typical DNDs. Both of these product lines are sold as colloidal suspensions in water, though suspensions can be made available in the following solvents: Polyalplaolefin (PAO) synthetic oil, Kerosene, Ethylene Glycol (EG), N-methyl pyrrolidone (NMP), Glycerol (Gly). Primary particles of detonation nanodiamond offer a robust platform for the delivery of molecules or drugs, with an extremely high surface area to volume ratio (~350 m^2 /g) and spherical shape (Figure 1). Raman spectroscopy verifies the presence of the diamond phase (Figure 2).



<u>Figure 1:</u> High Resolution TEM (HRTEM) image of primary particles of detonation nanodiamond.



<u>Figure 2:</u> Raman specta of 5 nm DND showing characteristic DND Raman peak at 1327 cm^{-1} .

The particles exhibit a rich surface chemistry, which can be easily modified and functionalized using standard reaction procedures. For most bioapplications, the presence of surface terminal carboxylic acid groups (-COOH) can be modified using standard carbodiimide chemistry (e.g. EDC/NHS) for the attachment of primary amine derivatives or proteins. Functional species can be covalently linked, or, in the case where molecule delivery is required, physically adsorbed to the particle surfaces. A typical FTIR spectra for DND is shown in Figure 3, with carbonyl peak at ~1770 cm^{-1} .

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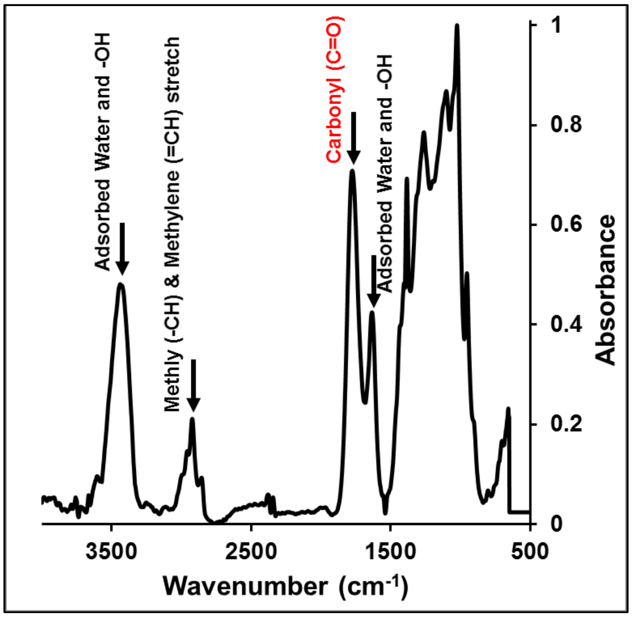

Figure 3: *FTIR of carboxylated 5 nm nanodiamond.*

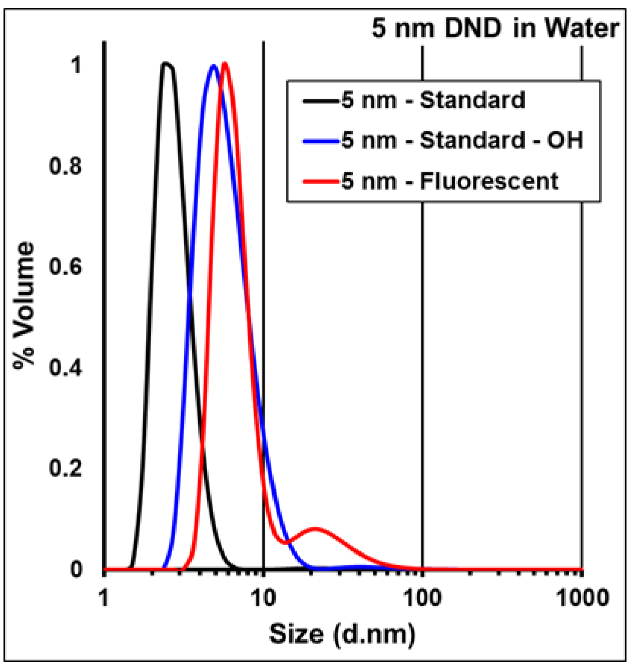

Figure 4: *Volumetric DLS size distributions of standard and fluorescent series in deionized water*

5 nm Standard Series

The standard 5 nm series consists of two functionalities of particles : carboxylated (-COOH) and hydroxylated (- OH). The carboxylated variant has a negative zeta potential (around -35mV) at pH ~7, wherease the hydroxylated variant has a positive zeta potential (+35mV) at pH ~7. Dynamic light scattering (DLS) size distributions for these two materials are shown in Figure 4. Both the hydroxylated and carboxylated versions are sold in water suspensions at 10 mg/mL

5 nm Fluorescent Series

The fluorescent 5 nm series has a carboxylated surface and negative zeta potential in DI water at pH~7. Their fluorescence originates from carbon dot structures on the surfaces of the particles. These fluorescent ~1 nm structures arise from specific processing conditions during the oxidation of the detonation soot following synthesis. These fluorescent particles are not as bright as typical fluorescent dyes, but they offer a unique sub-10nm probe with intrinsic fluorescence for intracellular tracking (Figure 5)while providing maximum surface area availability for payloads. Optimal excitation is around 400 nm, though the use of a laser can provide sufficient luminescence at higher excitation wavelengths. The emission spectra under blue excitation (~ 470 nm) is shown in Figure 6. Peak emission is about 520 nm.

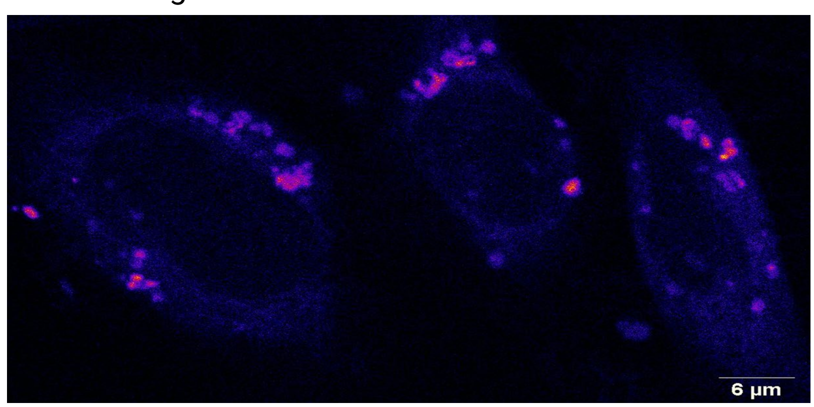

Figure 5: *5 nm Fluorescent particles internalized in MDA-MB-231 breast cancer cells. 488nm laser excitation (500-550 emission window). N. Prabhakar, Åbo Akedemi, Finland.*

5 nm Particles in Organic Solvents

Owing to their small size and rich surface chemistry, 5 nm nanodiamond particles can be stabilized in a large number of different solvent systems. This versatility allows for rapid implementation into your specific application area where solvents other than water are desired. Stable suspensions in base oils and fuels such as polyalphaolefin (PAO) and kerosene can be used in machinery and automobile engines for enhanced fuel efficiency, whereas suspensions in glycerol can be used in biological and pharmaceutical applications. Few (if any) nanoparticle systems can offer this degree of versatility. NOTE: the PAO and Kerosene suspensions are mixed with proprietary dispersants which causes the particle size to increase. However, 5 nm particles are used as a precursor for these products.

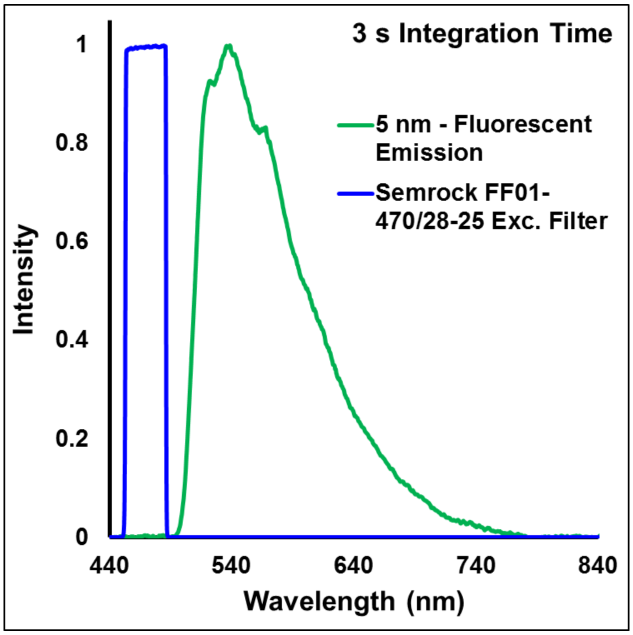

Figure 6: Emission spectra of carbon dot decorated 5 nm fluorescent DND solution under ~470 nm excitation (Semrock) at 1% w/v (10 g/L) concentration.

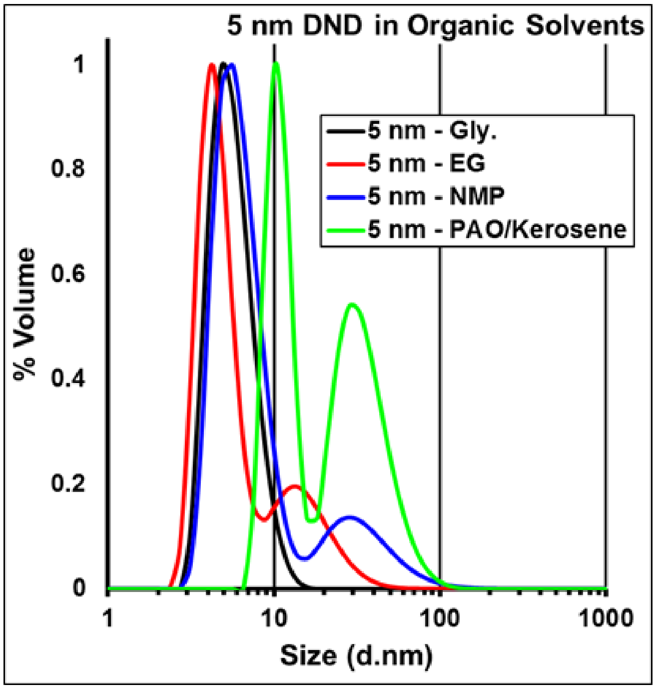

Figure 7: Volumetric DLS spectra of 5 nm nanodiamond particles in a variety of organic solvents.

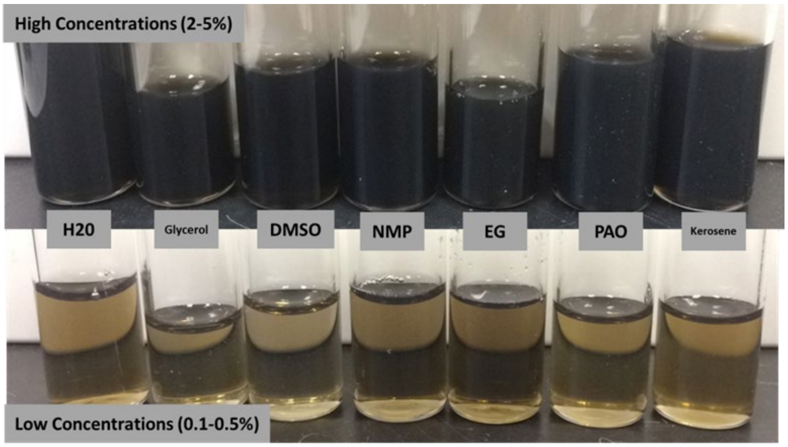

Figure 8: Dispersions of 5 nm nanodiamond particles in a variety of organic solvents at high concentrations (2-5% w/v) and low concentrations (0.1-0.5% w/v). High colloidal stability in a variety of solvents provides functionality in a large number of applications.

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Brilliant Diamond Solutions

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Product Sheet

Product	Suggested Application	Sold As*	Catalogue No.	Price
5 nm Standard	Drug Delivery, Bioconjugation	10 mg/mL in DI water	ND5nmNH2O100ml ND5nmNH2O500ml ND5nmNH2O1000ml	$98 $400 $750
5 nm Standard - OH	Drug Delivery, Bioconjugation	10 mg/mL in DI water	ND5nmOHH2O100mL	$175
5 nm - Fluorescent	Drug Delivery, Bioconjugation, Intracellular tracking	10 mg/mL in DI water	ND5nmFlH2O100ml ND5nmFlH2O500ml ND5nmFlH2O1000ml	$98 $400 $750
5 nm – EG	Polymers, Composites	10 mg/mL in Ethylene Glycol	ND5nmEG100ml	$250
5 nm - NMP	Polymers, Composites	10 mg/mL in N-Methylpyrrolidone	ND5nmNMP100ml	$300
5 nm – GLY	Drug delivery, Bioconjugation	10 mg/mL in Glycerol	ND5nmGly100ml	$250
5 nm – PAO*	Fuel/Oil Additive, Lubricants	10 mg/mL in Polyalphaolefin base oil	ND5nmPAO100ml	$250

*Contains proprietary dispersants to assist in colloidal stability

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