Detonation Nanodiamond Powder

Technical Info

Detonation nanodiamond (DND) is produced from the carbon contained in high-energy explosives. Such explosive compounds simultaneously serve as sources of energy and carbon. The characteristic size of primary particles is ~ 4 nm, which are consolidated into larger aggregates formed during synthesis and purification. It is not possible to break DND aggregates into primary particles by sonication; for this, milling with hard beads is required.

DNDs contain a wide variety of surface functional groups following extraction from detonation soot at the vendor site. As-produced detonation diamond nanoparticles are hydrophilic and can be chemically functionalized for specific applications. As-produced DNDS have either positive or negative zeta potential depending on a purification method used by a vendor.

For our customers we provide an option to purchase as-produced ("raw") DND powder, a powder of grey coloration, with either negative or positive zeta potential (when dispersed in DI water). The sign of zeta potential of DND is important in applications where electrostatic interactions are significant (e.g. adsorption of charged species can take place). We sell raw DND as powders, which is easy for transportation.

However, depending on the applications, customers of raw DND powder might need to perform additional purification using acids, specific surface functionalization, fractionation into narrow and smaller particle fractions. DND in powder form is also needed for some follow-up functionalization (e.g. reduction reaction). We also provide powders additionally purified from metal impurities and functionalized with specific surface groups (e.g. carboxylic acids).

DND dispersed in solvents are also available from Adámas. Traditional DND applications include galvanic coatings, polishing pastes and suspensions, polymer composites, lubricating oils and greases, catalyst support, battery additives.

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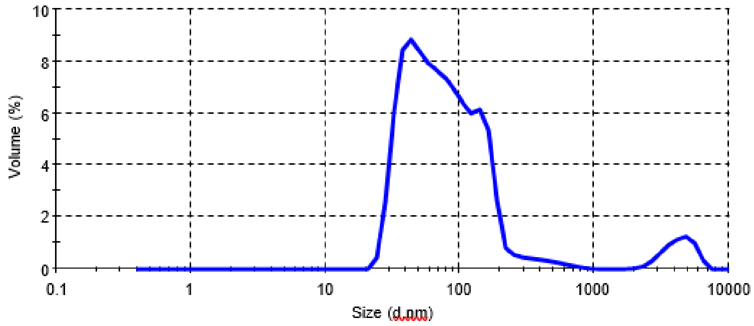
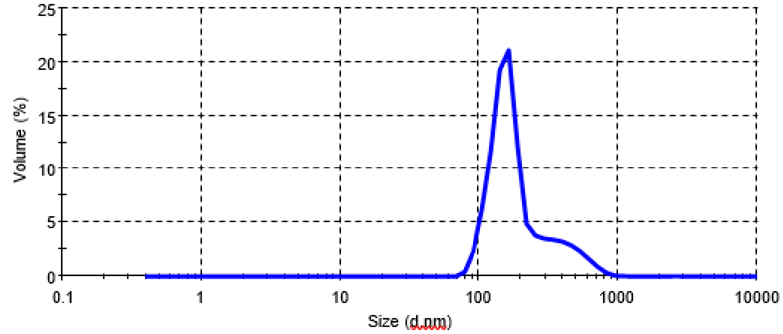
RAW DETONATION NANODIAMOND POWDER WITH POSITIVE ZETA POTENTIAL

As is raw DND products have low colloidal stability in DI water without additional acid treatment. When dispersed in DI water by sonication (using an immersed sonic horn), the particles are polydispersed and additional larger sizes fractions are also present (Figs.1 and 2).

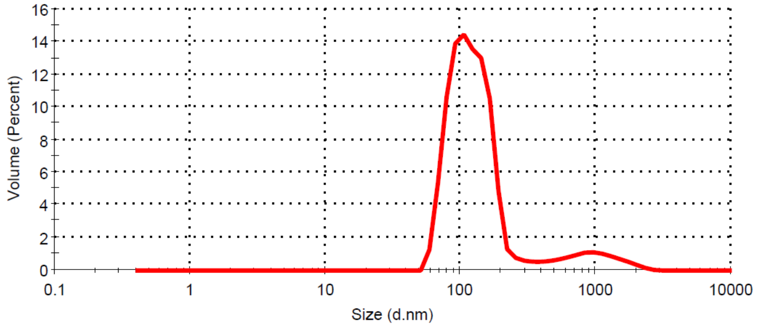


*(**Figure 1**) : Volumetric particle size distribution of **NDStandard** DND particles (170 nm z-average size) dispersed in DI water as measured with dynamic light scattering on a Malvern Zetasizer Nano ZS (Malvern Instruments, Ltd. UK). Zeta potential is +20 mV.*



*(**Figure 2**) : Volumetric particle size distribution of **NDLStandard** DND particles (230 nm z-average size) dispersed in DI water as measured with dynamic light scattering method. Zeta potential is +20 mV.*

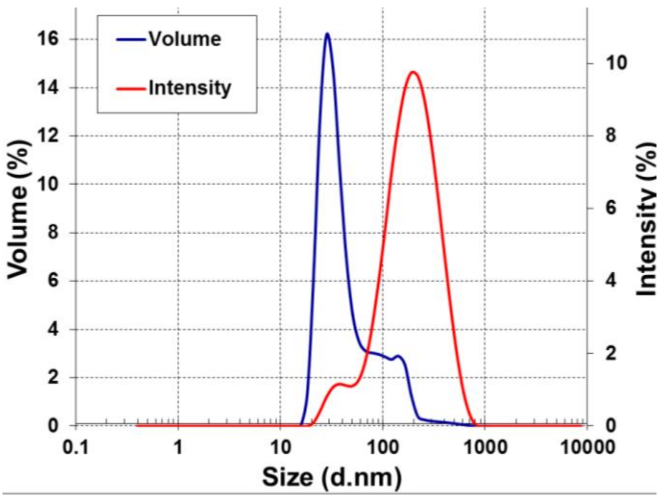
RAW DETONATION NANODIAMOND POWDER WITH NEGATIVE ZETA POTENTIAL



*(**Figure 3**) : Volumetric particle size distribution of **DND-2** particles dispersed in DI water (200 nm z-average size) as measured with dynamic light scattering method. Zeta potential is -15mV.*

As is raw DND products have low colloidal stability in DI water without additional acid treatment. When dispersed in DI water by sonication (using an immersed sonic horn), the particles are polydispersed and additional larger sizes fractions are also present (Fig.3). Ash content (incombustible impurities) in raw DND powder is ~2wt%. Table 1 summarizes characteristics of raw DND products.

CARBOXYLATED DETONATION NANODIAMOND POWDER



*(**Figure 4**) : Particle size distribution ofcarboxylated **NDStCOOH** particles dispersed in DI water (190 nm z-average size) as measured with dynamic light scattering method. Zeta potential is -40mV.*

This variety of detonation nanodiamond (NDStdCOOH190nm) is a higher purity grade of polydispersed negatively charged DND powder with an incombustible impurity (ash) content of approximately 0.6 wt % due to additional acid cleaning. Featuring a surface chemistry of predominantly carboxylic acid (-COOH) functional groups, this powder exhibits relatively high colloidal stability in deionized water (when effectively dispersed) with a resultant highly negative zeta potential.

Due to the higher purity of the material, there is a significant presence of small (<100nm) ND particles present when suspended in an appropriate solvent; however, larger aggregates leads to a degree of turbidity due to their significant scattering of light. Particles of 30 nm and 60nm in size extracted from the polydispersed material and dried are also available in powder form.

Effective use of the material requires identification of an appropriate solvent and subsequently dispersion via the use of an ultrasonic horn or powerful shear mixing.

Table 1: Summary of characteristics of raw detonation powder and polydispersed carboxylated powder available from Adámas.

Name	Z-Average size (nm)	Zeta Potential (mV)	Ash Content wt%	Surface Chemistry	Dispersability in DI Water
NDStCOOH	190 nm	-40 mV	0.6 %	Carboxylated	Well dispersible with sonication
NDStandard	170 nm	+20 mV	1.7 %	Amphoteric groups	Low
NDLStandard	230 nm	+20 mV	2 %	Amphoteric groups	Low
DND2	200 nm	-15 mV	2 %	Amphoteric groups	Low

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