Nanocomposites and nanomaterials

Properties and functionalization of nanodiamonds, produced by Light Hydro-Dynamic Pulse (LHDP) technology

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Nanodiamond (ND) powder contains carbon nanoparticles with cubic diamond structure in the core and onion-like hybrid shell with various functional groups on the surface [1]. Controlling the size and surface chemistry of ND defines their applicability in industry and the possibility to exploit unique features of diamond in nano-medicine. ND properties, such as high bio-compatibility, tiny size, possibility to interact with bio-molecules, the highest hardness and thermal conductivity, stable photoluminescence and high paramagnetism, are very important for bio-imaging and Theranostics.

Here we present results of the characterization and chemical functionalization of ND produced by LHDP method [3]. Our goal was to obtain stable aqueous sols with disaggregated ND in the presence of biological buffers.

Two samples of ND: RayND-L with hydrogenated surface and RayND-AL with hydrogenated & nitrogenized surface, were analyzed. According to TEM, both samples contain small (5 nm in average) primary particles forming aggregates. RayND-AL particles are covered with ≈1 nm amorphous layer of nitrogen containing groups. The sample RayND-L is hydrophobic. Thermal oxidation of RayND-L followed by alkaline treatment allowed to obtain stable aqueous sol with almost disaggregated ND (10-12 nm by the DLS method). The sample RayND-AL is more hydrophilic than RayND-L; it forms stable aqueous sols with partially aggregated particles (55 nm by DLS) without any additional treatment. However, the both sols coagulate rapidly in the presence of DMEM buffer widely used in biological researches.

Chemical functionalization of thermally-oxidized RayND-L by aminated block-copolymers of PPG (CAS 77110-54-4; 65605-36-9) and by N,N-dinonylamine was carried out in non-polar solvents. Covalent bonding of functionalizing agents was confirmed by FT-IR and TPD-MS data. NDs with grafted PPG groups demonstrate high stability of ND aqueous sols in presence of DMEM buffer.

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