Applications of Nanodiamond and Onion-like Carbon Particles in Composites

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Within the last few years world-wide interest in applications of nanodiamond particles has grown rapidly. Nanodiamond particles with the smallest monocrystalline size of about 4nm are produced by detonation of carbon-containing explosives, so called detonation nanodiamonds (DND). Numerous applications of DND are under development including high precision polishing; wear resistant additives to metal coatings; anti-friction additives to lubricants and oils; polymer nanocomposites and coatings with enhanced strength, impact resistance, and scratch resistance; nanocomposites with improved thermal stability and thermal conductivity; UV-protection coatings, sunscreens; seeding slurries for growth of CVD diamond films and many others applications. Also, DNDs serve as a source material for the production of onion-like carbon (OLC) by high temperature annealing of DND in an inert atmosphere. Recently it was demonstrated that OLCs are strong absorbers of electromagnetic (EM) radiation from the gigahertz, to terahertz, to visible spectral ranges, providing efficient EMI shielding. Several examples of applications under development at ITC and its collaborators using the modified/fractionalized DND will be discussed with major emphasis on applications of DND and OLC in composites. For example, it was demonstrated that nanodiamond particles in a polydimethilsiloxane matrix attain very pronounced photoluminescent when irradiated with a flux of MeV protons. This suggests application of the ND-polymer coatings as fluorescence-induced indicators of acquired proton dose, for example, by spacecraft. We will report on the fabrication of novel composites of carbon nanotubes incorporated into a nanodiamond matrix producing mixtures from nanocarbons that are complementary in chemical and mechanical strength and are expected to produce unique physical properties. Photonic structures made of DND as well as other applications will be also discussed. Results of tribological testing of stable colloidal dispersions of DND in polyalphaolefine (PAO) oil will be reported. DND-PAO colloids are transparent and have a specific amber color. The results of tribological tests from pure PAO oil and different formulations with DNDs demonstrated very significant improvements for all tribological characteristics for certain formulations. Effects of different parameters of the formulations on their tribological properties will be discussed.