Synergistic Effect of Anionic and Cationic Dispersants in the Preparation of Nanodiamond Nonpolar Suspensions

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For the preparation of well-dispersed detonation nanodiamond (DND) suspensions with good stability, an anionic surfactant, oleate acid (OA), and cationic surfactants such as octadecyl amine (ODA) and a dispersant with a polyester chain (herein called PEA) were introduced to a nonpolar solvent, petroleum ether, to modify the DND particle surface.

Due to the limitation of ionization of functional groups on DND surface and of surfactants in the nonpolar surrounding, the electrostatic repulsion between DND particles is slight. Yet, enhanced dispersion effect can be observed in the binary system of oleate acid/cationic dispersant mixture. Surfactants adsorb onto the DND particles, which possess high surface activity, in forms of physi- or chemisorption, and the synergistic coadsorption of anionic/cationic dispersants can be further expected. The strong electrostatic interaction of polar head groups with opposite charge of OA and cationic surfactants, namely, carboxyl group and amine group, may advance the dispersants' coadsorption on the DND surface, and the interaction between nonpolar hydrocarbon tails of dispersants may strengthen the steric repulsion between DND particles, and hence improve the dispersion performance of DND particles in the petroleum ether solvent. A hypothesis on the synergistic effect was discussed based on the entropy repulsion model. After the milling treatment, stable suspensions containing homogeneously distributed DND particles with an average diameter of around 20 nm (DND core with an polymer coating) can be prepared.

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