Detonation nanodiamonds as revealed by differential scanning calorimetry

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Detonation nanodiamonds (DND) is a useful nanomaterial with many potential applications in material science, biology and medicine. Various forms of DND (dry powders or flakes, aqueous gels, dispersions) were carefully studied and characterized by different experimental methods. The moSt valuable characteristics are size and structure of the primary particles (x-ray, HRTEM, NMR and etc), chemical identity of the surface groups (IR), size of the clusters in the dispersions (DLS, SANS).

In present study we introduce additional analytical tool to gain some insight into the properties of DND, namely, differential scanning calorimetry (DSC). The original idea was to determine the size of the liquid nanoparticles confined in DND samples using Gibbs-Thomson equation. DSC fills the gap in the understanding of state of DND gels and dry powders. It has a unique sensitivity towards disintegration process in DND. Chemically bonded aggregated samples can be easily distinguished from the dry powders/gels consisted of non-bonded primary particles (d~5nm). This is hardly possible with any other method. There is a strong correlation between DSC and DLS data. One may estimate possible size of the ND cluster in dispersion based on the preliminary DSC trace of DND gel or powder, e.g. *prior to preparation of dispersion.*

It was demonstrated that disintegrated DND forms a “secondary structure”, consisted of primary particles and a system of voids of certain reproducible size (d~8 nm) and volume. This reproducible “structure” was observed in dry powders, gels and indirectly in large porous clusters (d ~ 50 nm) dispersed in water. Similar structures were found earlier in dry carbon nanohorns and C_{60} aqueous gels.

With DSC it was possible to follow the steps of formation and collapse of a “secondary structure”. The former was observed in chemical disintegration of crude DND samples and the latter after high pressure treatment (~10 kbar, 900 K) of originally disintegrated samples. The attempts were made to detect the “secondary structure” in DND by means of HRTEM, STEM, AFM and etc.

The DSC data for DND samples of different origin are presented. Typical traces of aggregated, disintegrated and modified DND are given. The results were discussed along with data of other experimental methods (DLS, adsorption, HRTEM and etc.)

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