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Colloidal stability of synthetic hydrogenated nanodiamonds in water

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Two main processes are used to synthesize nanodiamonds (NDs): (i) by detonation (DND) giving rise to 5 nm mono-dispersed but highly defective nanoparticles, or (ii) by milling of bulk diamond (natural or synthetic) into polydispersed nanoparticles (MND). The latter preserves the crystallinity of bulk diamond and similar semi-conductor properties suitable for energy related applications. Able to host NV or SiV color centers, these MND are also currently under study for nanomedicine or quantum applications[1]. These applications imply a fine control of colloidal properties, especially for a hydrogenated surface chemistry. Hydrogenated DND colloidal stability is well understood but its hydrogenated MND counterpart still needs further comprehension for a stability over time.

State of the art research has demonstrated that sp^2 carbon content, generated by a prior vacuum annealing, is essential to confer the colloidal stability to MND hydrogenated under pure H_2 in mild conditions[2]. The present study reports on another route towards colloidal hydrogenated MND, which relies on the direct treatment of untreated MND at high annealing temperature (750°C) and under hydrogen pressures ranging from 10 mbar to atmospheric pressure. Our results show the possibility to obtain stable suspensions of hydrogenated MND over several months. Colloidal properties were investigated through DLS, zetametry and SAXS measurements. A thorough analysis of surface chemistry and morphology (FTIR, XPS, Raman, SEM, XRD) enables us to correlate stability of H-MND to their surface chemistry. Finally, the origin of the colloidal stability of hydrogenated DND and MND will be discussed.

References

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