Detonation Nanodiamond Slurries for Nucleation of CVD Diamond Films

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The quality of thin polycrystalline CVD diamond films depends heavily on the initial nucleation density, seed size range and distribution uniformity. While explosively formed nanodiamonds are considered an excellant sorce of nuclei for polycrystalline diamond film growth, a perfect seeding solution remains elusive for most CVD diamond growers. To our thinking, the ideal seeding solution is one with diamond particles as small as possible (eg. 4-6 nm size) which do not agglomerate in solution, are held in suspension for indefinite period time, and which can coat a substrate conformally with at least a monolayer of seeds. Such solution should facilitate reproducible deposition of a dense single layer of diamond seeds using a straightforward process.

This study is a part of ongoing effort to improve the seeding technique, with the focus on the seeding solution itself. For testing CVD diamond films were fabricated using the same seeding technique and identical growth conditions, but different seeding solutions: one was DMSO based nanodiamond suspensions, while the other one was an ethanol based. For consistent initial conditions, all silicon substrates underwent the SC-I cleaning procedure. Nanocrystalline diamond films were deposited on quarters of 4”Si and Si/SiO_2 wafers using microwave plasma CVD with the following growth conditions: 750°C, 0.3% CH_4, bal. purified H_2, 15 Torr, 800 Watts. The CVD samples with SiO_2 layer were later tested for pinholes by dipping them in HF. The seeded samples and grown diamond films were analyzed by SEM, some on both the nucleation side (after etching the substrate) and the growth surface. AFM, CV and IV analyses are presented as well. Comparisons between the resulting films are made to quantify the efficacy of the new DMSO-based solution with respect to the better understood ethanol-based suspensions.