Nucleation of CVD diamond particles and films on heat-treated polymers PHC and PNHC

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Formation of nucleation centers (seeding) on the substrate is a necessary step for CVD diamond growth, detonation nanodiamond particles commonly used now for this purpose. Here we report on alternative approach for the seeding that is based on heat treatment of a specific polymer layer, rich in sp^3 bonds, to produce nanodiamond particles (along with other carbonaceous species) [1,2], which serve further for diamond film nucleation.

Two types of polymers, poly(hydrocarbine) (PHC) and poly-(naphthylhydrocarbine) (PNHC), used as precursors, were spun-off on silicon substrates, and annealed at temperatures up to 700°C for 2 hours in Ar atmosphere to form diamond nuclei. Then the diamond films were deposited in a microwave plasma CVD system UPSA-100 (2.45 GHz) in the H_2/CH_4 gas mixtures for time intervals from 1 minute to 2 hours. Either isolated CVD diamond particles or continuous films were grown depending on deposition conditions.

Analysis of the samples before and after CVD process was performed with SEM and Raman spectroscopy (488 nm wavelength excitation). While only sp2-bonded carbon could be revealed in the annealed polymer products, diamond structure (with narrow Raman peak at 1333 cm^{-1}) was definitely was detected in the films just after first minutes of CVD process, confirming the presence of diamond nucleation sites with submicrometer dimensions in the polymer. The results of selective etching of graphite-like component from the polymers by oxidation and hydrogen plasma treatment to enrich the nucleation layer with diamond phase will also be reported. We believe that the use of the polymer precursors for seeding is especially helpful in case of porous substrates, e.g. zeolites, opals or nanoporous semiconductors.

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