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Mechanism and Visualization of Nano-Diamond Films Deposited by the DC-GD-CVD Process.

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Nano-crystalline carbon films with a predominant diamond character can be deposited from a methane –hydrogen gas mixture using the direct current glow discharge chemical vapor deposition (GD-CVD) process. The evolution of the precursor material for diamond nucleation and the development of the nanodiamond film are visualized by high resolution electron microscopy, NEXAFS spectroscopy and other spectroscopic methods. The nanodiamond film and growth is explained as a sub-surface process in terms of a four step cyclic process and supported by our recently proposed mechanism of diamond nucleation (Science **297** 1531 (2002)) and sub-plantation growth:

- (1) Formation of a dense, hydrogenated amorphous carbon (a-C:H) layer.
- (2) Precipitation of sp^3 C clusters in this a-C:H phase.
- (3) Growth of nano-diamond particles up to ~5 nm in size by energetic species bombardment of the diamond / a-C:H interface. It involves preferential displacement of loosely bonded carbons leaving diamond carbon atoms intact, leading to expansion of the diamond phase at the expense of the a-C:H phase.
- (4) Frustration of growth of the diamond particles.
- (5) Growth of the film formed of an agglomerate of nano-diamond particles by a cyclic process which involves process 2-4.

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