FABRICATION AND PROPERTIES OF NANOCRYSTALLINE DIAMOND FILMS

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The properties of single crystal diamond surpass all the properties of single crystal silicon. Still, due to many technological challenges, diamond has not been introduced in the semiconductor industry yet. In comparison with Si, the technology for producing large single crystal diamonds and shallow n-type doping still lacks.

Highly pure diamond layers are deposited by microwave plasma enhanced chemical vapor deposition (MWPECVD) where microwaves excite a carbon source, mostly methane, and an abundance of hydrogen ($\approx$ 99%) into plasma. When introducing a boron containing gas into the plasma, boron is substitutionally incorporated in diamond [1] and acts as a p-type dopant with an energy band at approximately 0.36 eV above the valence band [2].

Last decade, a way of producing very thin diamond layers; starting from 40 nm; on large surfaces has been introduced [3] and generally used by the diamond community. These layers, named nanocrystalline diamond (NCD) layers, are typically grown with chemical vapor deposition at temperatures ranging from 400 to 1000°C. NCD exists of small diamonds (grains), closely grown towards each other and separated by grain boundaries, which consist of sp^2 carbon. Due to the grain boundaries in this material, some properties are lost, compared with single crystal diamond. Still many useful features (chemical inertness, Young's modulus, electrochemical properties, etc.) remain. For instance, heavily boron-doped diamond samples, at the metallic side of the metal-insulator transition, show electronic properties, close to those of heavily boron-doped single crystal diamond [4].

A detailed explanation of the production process, growth chemistry and properties of intrinsic and heavily boron-doped nanocrystalline films will be given.

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References

[1] S. Turner, Y.-G. Lu, S.D. Janssens, F.D. Pieve, D. Lamoen, J. Verbeeck, K. Haenen, P. Wagner, and G. Van Tendeloo, *Nanoscale* **4**, 5960 (2012).

[2] T.H. Borst and O. Weis, *Diam. Relat. Mater.* **4**, 948 (1995).

[3] O.A. Williams, O. Douhéret, M. Daenen, K. Haenen, E. Osawa, and M. Takahashi, *Chem. Phys. Lett.* **445**, 255 (2007).

[4] S.D. Janssens *et al.*, *New J. Phys.* **13**, 083008 (2011).