Doped Nanodiamonds: Chemical information at the atomic scale via EELS

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Chemical analyses at the local (sub-nanometer/atomic) scale are crucial for improving the understanding of materials. For instance, for doped carbon nanostructures (as those of diamond family), these analyses are critical because their properties strongly depend on the chemical environment/configuration of the dopants [1-4]. Electron energy-loss spectroscopy (EELS), developed in an aberration-corrected TEM (having access to a close to 1 angstrom electron probe), is an essential and powerful technique to perform such local chemical analyses [2-4]. In this contribution, we will present a detailed study of the structure and local composition of nitrogen-doped ultrananocrystalline diamond (UNCD) films [5-8]. Under normal process conditions, these UNCD films are highly electrically insulating, but they can become highly conducting when Ar is substituted in the synthesis gas with some of N2 [1, 4-8]. The formation of these NWs starts to appear when the N2 content in the gas phase reaches about 10% in volume. From these studies, we concluded that the insulator-metal transition of these films is strongly correlated with the formation of these diamond NWs. Indeed, these NWs are enveloped by a sp2-based carbon layer providing the conductive path for electrons [5-8]. In summary, these studies elucidate crucial questions concerning the local composition (atomic configuration) of these materials. This detailed knowledge is essential for better understanding the outstanding properties of such materials.

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