

Nitrogen doping of detonation nanodiamonds

Pichot V.^{1*}, Stephan O.², Comet M.¹, Mory J.¹, Fousson E.¹,
March K.², Spitzer D.¹

¹NS3E « Nanomatériaux pour les Systèmes Sous Sollicitations Extrêmes » UMR CNRS-ISL
n° 3208, French-German Research Institute of Saint-Louis, 5 rue du général
Cassagnou 68301 Saint-Louis, France

²Laboratoire de Physique des Solides (UMR CNRS 8502), bât. 510,
Université Paris Sud, 91405 Orsay, France

*e-mail: vincent.pichot@isl.eu

The presence of nitrogen/vacancies inside nanodiamond particles is of great importance to confer them luminescent properties which open a wide field of applications in biology and in quantum physics. Bradac et al. has reported an intermittency luminescence in 5 nm detonation nanodiamonds [1]. Varying nitrogen content inside detonation nanodiamonds should be very helpful to obtain stable photoluminescence properties.

Ultra-nanocrystalline nanodiamonds are synthesized at the ISL by detonation using a high explosive mixture composed of trinitrotoluene (TNT) and hexogen (RDX) (70/30). The detonation of the charge leads to a powder containing nanodiamond crystallites ($\Phi \sim 5$ nm) [2]. The content of the nitrogen present inside these as-synthesized nanoparticles was determined by Electron Energy-Loss Spectroscopy (EELS) and is about 3 wt.%. EELS is a very useful tool for determining the location and the quantity of nitrogen within individual nanodiamonds [3, 4]. The doping nitrogen comes from the explosive molecules which contain a lot of nitrogen atoms. A study on the nitrogen doping of detonation nanodiamonds was carried out.

The experimental results demonstrate that the nitrogen content strongly depends on the precursors used in the explosive charge composition. We have demonstrated that with the incorporation of a nitrogen rich compound, it is possible to increase the nitrogen content by a factor two or three. Such high nitrogen contents have never been reported in detonation nanodiamonds. A careful study of the nitrogen spectroscopic signature revealed that it is present inside the nanodiamond core in a sp^3 hybridization configuration [4].

- [1] Bradac C., Gaebel T., Naidoo N., Sellars M. J., Twamley J., Brown L.J., Barnard A.S., Plakhotnik T., Zvyagin A.V., Rabeau J.R., *Nature Nanotechnology* **5**, 345 (2010).
- [2] Pichot V., Comet M., Fousson E., Baras C., Senger A., Le Normand F., Spitzer D., *Diamond and Related Materials* **17**, 13 (2008).
- [3] Turner S., Lebedev O.I., Shenderova O., Vlasov I.I., Verbeeck J., Van Tendeloo G., *Advanced Functional Materials* **19**, 2116 (2009).
- [4] Pichot V., Stephan O., Comet M., Mory J., Fousson E., March K., Spitzer D., *Journal of Physical Chemistry C* **114**(22), 10082 (2010).