Synthesis of loose nanodiamonds with embedded colour centres by chemical vapour deposition

Alexandre Tallaire[1,2]
Mary De Feudis[2], Lahcene Mehmel[2], Ovidiu Brinza[2], Philippe Goldner[1], Jocelyn Achard[2]
Institut de Recherche de Chimie Paris, Chimie ParisTech, CNRS, Université PSL, France

Abstract

In the past decade, diamond has been become one of the most studied solid-state materials to address sensing applications in the emerging field of quantum technologies. Those sensors exploit the optical and spin properties of point-like defects such as the well-known nitrogen-vacancy (NV) centre. The ability to optically spin-polarize and read-out the spin-state of those colour centres at room temperature is at the basis of significant advances in highly sensitive magnetic field diamond probes. In general, bulk diamond crystals are used as they offer long spin coherence times when NVs are embedded in a highly pure and defect-free crystalline environment. On the other hand, the development of smaller luminescent nanocrystals would further accelerate material integration by enabling, besides a potentially lower fabrication cost, an easier coupling to resonant cavities or to hybrid structures as well as, due to diamond bio-compatibility, the realisation of probes for in-vivo bio-imaging.

Currently two main nanodiamond fabrication techniques are used: detonation synthesis and grinding of bulk crystals [3]. While they offer an industrial fabrication pathway, they also present limits in chemical composition control and luminescent centre incorporation. We have recently proposed an alternative approach to directly grow loose nanodiamonds containing luminescent colour centres using plasma assisted Chemical Vapour Deposition (CVD) [4]. By finely tuning the growth process, and adding dopants during growth such as N, Si or Ge, the creation of colour centres with a great control over the composition and optical properties is possible [5]. In this presentation, I will discuss the possibilities and limitations of this synthesis approach as well as the properties of the luminescent nanodiamonds with respect to their potential application in quantum technologies.

References

[1] Institut de Recherche de Chimie Paris, Chimie ParisTech, CNRS, Université PSL.
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