Nitrogen Vacancy Centers in Diamond for Bio-Sensing

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Nitrogen-vacancy (NV) centers are color-defects in the diamond crystal lattice which have raised a lot of attention in the last decades for their promising sensing capabilities (especially for magnetic field and temperature), based on spin-dependent photoluminescence. Moreover, diamond biocompatibility and good sensitivity at room temperature naturally lead to biological applications.

Both bulk diamond and nanodiamonds can be used in this context, each presenting its own advantages and challenges. In this presentation, I'll describe our recent results in both directions.

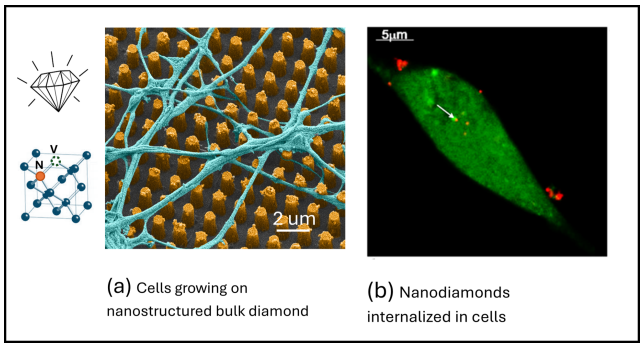

Figure 1: NV centers in diamond for bio-sensing

On one side I'll discuss how diamond chips can be nanostructured and used as substrates for cellular growth [1]. More specifically, we developed an optimized fabrication process of a large-scale single-crystal diamond nanopillar array. We extensively study how these structures improve the photoluminescence light collection efficiency from NV centers and how neurons grow on the fabricated surface, presenting scanning electron microscope images and studying the neurons preferential growth orientation at varying the array geometrical parameters. With electrophysiology we also demonstrate that the neurons are functionally active on the nanostructured surface, confirming the biocompatibility of the developed structures.

On the other side, I'll show how nanodiamonds can be used for nanoscale thermometry inside cells [2]. Our results demonstrate, for the first time, temperature variations associated with potentiation and depletion of neuronal firing. The potentialities of this technique are relevant and can benefit both from proper ND functionalization and optimization of the sensing protocol, potentially allowing to detect temperature variations below 0.1°C.

Both approaches can be combined with existing measurements techniques (*e.g.* with micro-electrode arrays (MEAs) devices) and give new insights on many biological processes which are still not completely understood.

References

[1] E Losero, S Jagannath, M Pezzoli, V Goblot, H Babashah, H A Lashuel, C Galland and N Quack, Sci. Rep. **13**, 5909 (2023)

[2] G Petrini, G Tomagra, E Bernardi *et al.*, Adv. Sci. **9**, 2202014 (2022)