SSF- O3

Diamond nanoneedles for biosensing

Mariam Quarshie[1], Sergei Malykhin[1], Lena Golubewa[2], Caterina Giraulo[3], Silvana Morello[3], Bo Xu[1], Priyadharshini Balasubramanian[4], Fedor Jelezko[4], and Polina Kuzhir[1]

[1]*Department of Physics and Mathematics, University of Eastern Finland, Joensuu, Finland.*
[2]*State Research Institute Centre for Physical Sciences and Technology, Vilnius, Lithuania.*
[3]*Dipartimento di Farmacia, Università Degli Studi Di Salerno, Salerno, Italy.*
[4]*Department of Quantum Optics, Ulm University, Ulm, Germany.*
Email: mariam.quarshie@uef.fi

Nanoparticles and nanomaterials (NMs) are revolutionizing medicine [1] by offering diverse tools for diagnosis and therapy [2], including devices, contrast agents, drug delivery systems, and theragnostic agents [3]. However, realizing their full potential requires a deep understanding of their interactions with biological cells. This study investigated the prospects of four batches of single-crystal diamond nanoneedles (SCDNNs), with sizes ranging between 200 nm to 1300 nm and concentrations of 240 mg/mL to 1000 mg/mL, containing silicon-vacancy (SiV^-) color centers for biosensing applications. The proof-of-concept demonstration was performed using human lung fibroblast cells. Employing micro-photoluminescence (PL) mapping, confocal microscopy and lactate dehydrogenase (LDH) viability tests, we evaluated the cellular response to SCDNNs. Intriguingly, our investigation with PL spectroscopy revealed that the cells and SCDNNs can coexist together with approved efficient registration of SiV^- (Fig. 1). Notably, LDH release remained minimal in cells exposed to optimally sized SCDNNs, suggesting a small number of lysed cells and indicating non-cytotoxicity of SDDNNs. The evidence obtained highlights the potential of SCDNNs for extra- or/and intracellular drug delivery when the surface of the needle is modified. In addition fluorescent defects in the SCDNNs can be used for bioimaging as well as optical and quantum sensing.

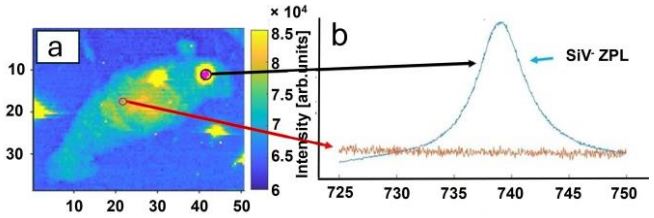

Fig.1 (a) Photoluminescence (PL) map and (b) spectra obtained with RENISHAW invia Raman spectrometer. The region revealing PL from SiV^- centers is marked with a pink spot (in (a)). The associated PL spectrum for this region is shown by the blue curve.

This work was supported by Academy of Finland (Flagship Programme PREIN, decision 346518; research projects, decision 357033; decision 340733; QuantERA project EXTRASENS, decision 361115); and Horizon Europe MSCA FLORIN Project (101086142).

[1] M. Joseph, D. Mahapatra, A. Esmaeili, L. Piszczyk, S. Hasanin, M. Kattali,... and S. Thomas; *Nanomaterials* **13** (2023) pp. 574.
[2] Y. Stasyuka, Z. Gaydaa, J. Serkiza, and V. Gonchara; *Journal of Advances in Chemistry* **11** (2015).
[3] S. Lozhkomoev, G. Mikhaylov, V. Turk, B. Turk, and O. Vasiljeva; *Multiscale Biomechanics and Tribology of Inorganic and Organic Systems*: In memory of Professor Sergey Psakhie (2021) pp. 211-223.