On the optimal chemical interface of diamond for quantum biosensing

Petr Cigler
[1]*Institute of Organic Chemistry and Biochemistry, of the CAS, Flemingovo nam. 2, Prague, Czechia*
[*]cigler@uochb.cas.cz

Non-perturbing sensing techniques applicable to biological systems are currently of central interest in the biosciences. Nanodiamond (ND) is a highly biocompatible nanomaterial for construction of nanosensors, which can accommodate nitrogen-vacancy (NV) centers. The NV spin properties can be read optically, which enables design of various probes based on quantum mechanical interactions. NDs can be exposed to biological environment and report sensitively on the spin-related processes occurring in a close vicinity of the particle employing for example the NV spin relaxometry measurements. ND relaxometry however reaches its limitations in terms of poor colloidal stability in physiological environment and non-specificity to detect only the magnetic field originated from the spins of interest.

To ensure colloidal stability in biologically-relevant environment we stabilize ND probes using thin polymer coatings that can be further modified to allow sensing of specific physical quantities or targeted molecules. To that end, we design molecular transducers for transposing the presence of particular analytes to a selective and unambiguous readout. Different types and concepts of surface architectures including those for selective measurements of pH, temperature, redox potential, and ascorbate concentration under physiological conditions will be discussed. Additionally, our recent developments of ND probes for detection of biomolecules using relaxometry together with a proof-of principle results will be presented.

Acknowledgement
This project has received funding from the European Union's Horizon 2020 research and innovation program. The work was further supported by the Czech Science Foundation project No. 23-04876S, the Ministry of Education, Youth, and Sports of the Czech Republic (project No. CZ.02.01.01/00/22_008/0004558, co-funded by the European Union), the European Union project C-QuENS (Grant No. 101135359), the Czech Academy of Sciences – Strategy AV21 – Research program VP29 (to P.C.), TACR project Nr. TH90010001 (QuantERA – ERA-NET Cofund, project EXTRASENS), and Horizon project No 101086142 (FLORIN).