Two birds with one stone: integrating exfoliation and biorecognition in multi-walled carbon nanotubes by functionalization with biomolecules

Gustavo Rivas[1]
Pablo Dalmasso[2], Michael López Mujica[1], Alejandro Tamborelli[1,2], Marcela Rodríguez[1], María Rubianes[1], Pablo Gallay[1], Virginia Vaschetti[1,2], Daiana Reartes[1], Rocío Delpino[1], Leonardo Bravo[1], Facundo Aghemo[1,2]
[1]*INFIQC, CONICET-UNC, Departamento de Fisicoquímica, Facultad de Ciencias Químicas, Universidad Nacional de Córdoba, Ciudad Universitaria, 5000 Córdoba, Argentina.*
[2]*CIQA, CONICET, Departamento de Ingeniería Química, Facultad Regional Córdoba, Universidad Tecnológica Nacional, Maestro López esq. Cruz Roja Argentina, 5016 Córdoba, Argentina.*
gustavo.rivas@unc.edu.ar

The development of biosensors able to meet the current requirements of Clinical Chemistry is a very important challenge in the field of electrochemical sensors. Carbon nanotubes (CNTs) have demonstrated to be an excellent material to build innovative and versatile electrochemical (bio)sensing platforms due to their unique properties, the possibility of easy functionalization, and the excellent contributions for an efficient transduction of the biorecognition event. Different alternatives to reduce the strong tendency of CNTs to form bundles and to improve their compatibility with the solvent have been reported in the last decades. In this talk, I will present an overview of the "smart" strategies to functionalize CNTs reported by our group in the last years, based on the rational selection of functionalization agents that simultaneously allow the exfoliation of CNTs and provide them with particular (bio)recognition properties.

Typical examples will be discussed in this presentation in connection with the use of critically selected biomolecules as functionalization agents: i) site-specific anchoring proteins like *avidin*, to obtain a multipurpose platform for the development of any kind of biosensor by simply selecting the adequate biotinylated biorecognition element, and *concanavalin A*, to obtain useful building blocks for glycobiomolecule-based biosensors; ii) enzymes like *glucose oxidase* and pseudo-enzymes like *cytochrome c* to obtain enzymatic biosensors without additional enzyme immobilization steps; iii) immunoglobulins to develop very innovative and versatile immunosensing platforms; iv) cysteine to take advantage of its complexing capability, and v) critically designed ligands to mimic the glycobiomolecule-anchoring capability of concanavalin A.

In summary, the excellent results provided by the biofunctionalized CNT-based biosensors in terms of sensitivity, selectivity, reproducibility, and ease of use, corroborate the potential and versatility of the resulting biomolecule-CNT nanohybrids, and demonstrate the importance of the rational biomolecule selection to functionalize the nanostructures, paving the way for further label-free, friendly and efficient biosensing applications.

The authors acknowledge CONICET, ANPCyT, and SECyT-UNC for the financial support.

References

[1] F. Gutierrez, M. D. Rubianes, G. A. Rivas, Analytica Chimica Acta, 1065 (2019) 19.
[2] E. Ortiz, P. Gallay, L. Galicia, M. Eguílaz, G. A. Rivas, Sensors and Actuators B. Chemical, 292 (2019) 254.
[3] P. A. Gallay, M. Eguílaz, G. Rivas, Biosensors and Bioelectronics, 148 (2020) 111764.
[4] M. López Mujica, M. D. Rubianes, G. A. Rivas, Sensors and Actuators B: Chemical, 357 (2022) 131304
[5] M. López Mujica, A. Tamborelli, C. Espinosa, V. Vaschetti, S. Bollo, P. Dalmasso, G. A. Rivas. Microchimica Acta, 190 (2023) 73.