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Scalable nanostructuring of optical probes for neurochemicals detection using atmospheric plasma synthesis of gold nanoparticles

Abstract

Measuring subtle variations of neurochemical concentrations in the brain is crucial to advance the diagnostic capabilities and treatments for brain disorders. Recently, nanostructured optical probes have emerged as a promising strategy to enable in situ monitoring of neurochemicals levels through surface enhanced vibrational spectroscopy [1].

We present an innovative approach for scalable nano-structuring of multimode optical fibers as enhanced neural probes using excitation-tuned plasmonic nanoparticles synthesized by atmospheric pressure plasma jets [2].

We show that our probes, that are both efficient in signal enhancement and biocompatible, enable an effective through-fiber SERS detection of target analytes at 0.1 micromolar concentrations (R6G), offering a potentially promising method for label-free detection of neurochemicals in deep brain regions.

[1] Lei et al, *J. Raman Spectrosc* (2025): 10.1063/5.0258376

[2] Nam et al, *Plasma Process Polym* (2024): 10.1002/ppap.202400140

Biography

Anna Roccaforte is a PhD student at the Padova Neuroscience Center (PNC) and at the Department of Physics and Astronomy "G. Galilei" in the University of Padua. She earned her master's degree in Physics with a thesis on the development and characterization of plasmonic nanostructures integrated on multimode optical fibers. Her current research focuses on the use of these fiber-based photonic probes to detect neurotransmitters in the brain. During her bachelor's thesis, she studied nanostructured iron thin films with catalytic properties, and she also gained experience at the National Laboratories of Legnaro contributing to the development of a silver-based radiopharmaceutical. Her scientific interests bridge nanotechnology, biophotonics and neuroscientific research.

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