Analytical Challenges in Microplastic Detection and the Promise of SERS Nanotechnology

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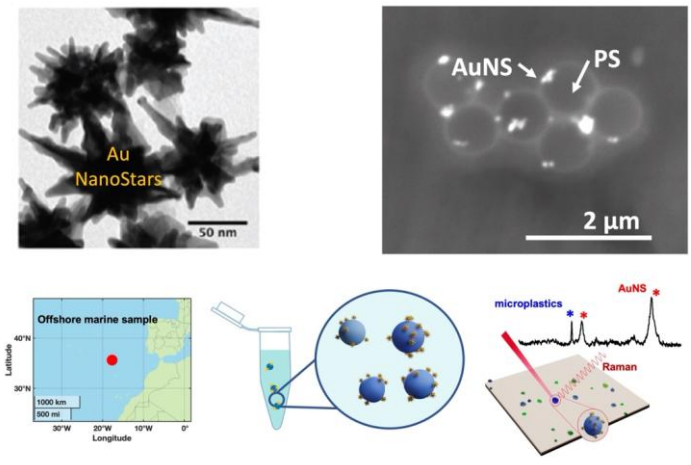
The ubiquity of micro- and nanoplastics (MNPs) has transitioned from an environmental concern to a global health emergency. MNP pollution, had been found across diverse scenarios: from pristine, remote environments like the open ocean,[1] to densely populated urban areas.[2] Furthermore, compelling evidence of MNP accumulation are reported within living organisms, spanning from African mammals to human tissues,[3] underscoring the urgent need for robust monitoring tools.[4] Despite their widespread presence, the reliable characterization of MNPs poses unprecedented analytical challenges. As analytes, microplastics exhibit extreme heterogeneity in size, shape, and polymer composition.[5] This complexity is compounded by the severe difficulties encountered during sample digestion and purification protocols, as well as the intrinsic limits of current instrumentation (e.g., standard FTIR and Raman), which struggle with spatial resolution and prohibitive acquisition times.

To address these limitations, this talk will introduce plasmonics and Surface-Enhanced Raman Scattering (SERS) as powerful solution.[6] It will be first discussed the fundamental optical properties of noble metal nanostructures and why their localized surface plasmon resonances (LSPRs) are uniquely suited for chemical sensing.[7] We will then demonstrate how engineered SERS nanostructures can be deployed to selectively target microplastic fragments, acting as optical "tags" that drastically accelerate screening and reduce overall analysis times.[8] Finally, the seminar will explore ongoing research into developing SERS platforms tailored for the label-free detection of sub-micron plastics, highlighting the promising breakthroughs achieved so far alongside the critical, open questions that the scientific community must still resolve to ensure reproducibility and quantification.



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