Nanotechnology applied to Micro- and Nanoplastics Analysis

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Microplastics pollution is being unanimously recognised as a global concern in all environments. The lack of standardized analytical methodologies reflects the challenging aim of providing robust and complete characterisation of these intrinsically heterogeneous materials. Routine analysis protocols foresee that samples, supposed to contain up to hundreds of microplastics, are eventually collected on nanoporous filters. All the particulates, namely made of plastic or not, must be therefore inspected to detect and count microplastics. Among the instrumental techniques applied so far, vibrational spectroscopy coupled to optical microscopy, i.e., μ-FTIR and μ-Raman, has recently established as the most promising approach, due to both morphological and chemical characterization. Thanks to its superior spatial resolution, μ-Raman emerges as the best candidate to address the smallest microplastics fraction, down to the so-called nanoplastics. However, small microplastics and nanoplastics are difficult to locate by optical microscopy, and Raman measures usually require long acquisition time. These two reasons alone almost prevent a routinely detection of nanoplastics in common environmental monitoring. Inspired by the principles of cell labelling, gold nanostars (AuNS) are functionalized to act as SERS-tags and selectively couple to polystyrene nanobeads (PS), as a first representative example of microplastics. The intrinsic bright signals provided by the AuNS are used to run a quick scan over a wide filter area with roughly two orders of magnitude shorter analysis time in respect of state-of-the-art in micro- and nanoplastics detection by μ-Raman. This novel application of SERS labelling, even if at proof-of-concept level at this stage, showed the potentials of been eventually implemented in environmental microplastics sampling and analysis, allowing fast detection of even the smallest microplastic fraction.