Raman Tweezers for micro and nanoplastics analysis in watery ecosystems

Antonino Foti[1], Raymond Gillibert[1], Alessandro Magazzù[1], Maria Grazia Donato[1], Onofrio Maragò[1], Agnese Callegari[2], Giovanni Volpe[2], Marc Lamy De La Chapelle[3], Fabienne Lagarde[3], and Pietro Giuseppe Gucciardi*[1]

[1]CNR – IPCF, Istituto per i Processi Chimico-Fisici – Viale F. Stagno D'Alcontres 27, I-98158 Messina, Italy

[2]Department of Physics, University of Gothenburg – 412 96 Gothenburg, Sweden

[3]Institut des Molécules et Matériaux du Mans, UMR 6283 CNRS – Le Mans Université – 72085 Le Mans, France

Abstract

Hybrid instruments combining Optical Tweezers (OT) with Raman spectroscopy (Raman Tweezers, RT) are becoming increasingly popular, as they enable measurements of size and composition of micro and nanoparticles in a contact-less fashion. RTs are gaining attention as a unique analytical tool for environmental sciences and food analysis, capable to detect and chemically identify micro- and nano-plastics (MNPs). Here we show optical trapping and chemical identification of sub-20 μm plastics, down to the 50 nm range by RT (1). Analysis at the single particle level allows us to unambiguously discriminate plastics from organic matter and mineral sediments, overcoming the capacities of standard Raman spectroscopy in liquid, intrinsically limited to ensemble measurements. Applications are demonstrated on both model particles and naturally aged environmental samples, made of common plastic pollutants, including polyethylene, polypropylene, nylon, and polystyrene, also in the presence of a thin eco-corona. Finally the analysis is extended to samples of tire and road wear particles collected from a brake test platform, where we highlight the presence of submicrometric agglomerates of rubber and brake debris, thanks to the presence of additional spectral features other than carbon (2). Either used to trap & analyse single particles or coupled to field-flow fractionation techniques, RT have the potential to fill the technological gap in MNP detection. In the next years research & development will be oriented towards the exploration of the full potential and limits of RT in terms of sensitivity, size limitations, multispectral analysis and chemical information that can be extracted from contaminated MNPs and in complex environments. (3)

(1) Gillibert et al. *Environ. Sci. Technol.* 2019, 53, 15, 9003

(2) Gillibert et al. Environ. Sci.: Nano, 2022, **9**, 145

(3) Volpe et al. Roadmap for Optical Tweezers, arXiv preprint arXiv:2206.13789 (2022)

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*Speaker