



XXII European Conference on  
**ANALYTICAL CHEMISTRY**

# EUROANALYSIS



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# ABSTRACT BOOK

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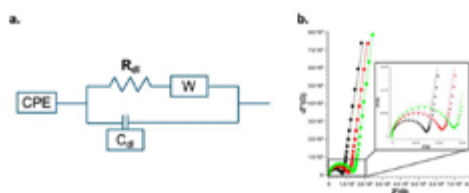
## INVESTIGATING MICROPLASTICS THROUGH ELECTROCHEMICAL IMPEDANCE SPECTROSCOPY: AN ANALYTICAL METHOD FOR THEIR LABEL-FREE ANALYSIS

Arrabito, Giuseppe<sup>1</sup>; Lascari, Davide<sup>1</sup>; Cataldo, Salvatore<sup>1</sup>; Muratore, Nicola<sup>1</sup>; Puleo, Giorgia<sup>1</sup>; Licciardi, Mariano<sup>2</sup>; Meringolo, Federica<sup>3</sup>; Costanzo, Paola<sup>3</sup>; Pettignano, Alberto<sup>1</sup>; Campanile, Floriana<sup>4</sup>; Pignataro, Bruno<sup>1</sup>.

<sup>1</sup>Department of Physics and Chemistry-Emilio Segrè, University of Palermo, Palermo, Italy; <sup>2</sup>Department of Biological, Chemical and Pharmaceutical Sciences and Technologies (STeBiCeF), Palermo, Italy; <sup>3</sup>Department of Chemistry and Chemical Technologies, University of Calabria, Rende, Italy; <sup>4</sup>Department of Biomedical and Biotechnological Sciences, University of Catania, Catania, Italy.

Molecular adsorption at immiscible interfaces is known to trigger up-concentration, leading to different chemical reactivity and interaction with solvents [1]. This process is not only fundamental for understanding life-mimicking artificial systems but also has important consequences in real-world contexts, such as the behavior of microplastics (MPs) in

natural environments. MPs can be defined as fragments of any type of plastic smaller than 5 mm that can exert toxic effects on humans for several reasons, especially due to the adsorption of toxic substances from the environment. In addition to the urgent need for rapid in situ identification and quantification that reduces the time needed compared to traditional laboratory methods, nowadays there is a growing demand for new methods to quickly assess whether MPs can absorb pollutants, especially metals cations [2]. For instance this phenomenon, mainly driven by electrostatic interactions, occurs at MPs' interfaces. To this aim, we have recently shown how electrochemical impedance spectroscopy (EIS) can quantify MPs in the absence of electrochemical mediators [3], resulting in LOD down to 0.07 % w/v. Unlike previous approaches, this method allows differentiation between virgin and lead-ions polluted MPs, by shedding light on the mechanisms involved in the electrostatic-driven pollutant adsorption at the MP surface. Our approach is based on an equivalent electrical circuit in which a constant phase element (CPE) is placed in series with the double-layer resistance ( $R_{dl}$ ) and the Warburg impedance (W) modelling the electrolyte diffusion process in parallel with the double-layer capacitance ( $C_{dl}$ ). The concentration of dispersed MPs is inversely proportional to the  $R_{dl}$  value. Following a simple calculation from the equivalent circuit model (Figure 1a), the  $R_{dl}$  value is chosen for MPs quantification purposes and is found to depend on the pollutant adsorbed at the MPs surface, in particular for polystyrene beads, as shown in Figure 1b. These findings are verified by independent  $\zeta$ -potential analyses. Herein, preliminary results show that this method can be extended to other types of MPs of natural or artificial origin, such as cellulose-derived or polyfluoroalkylated substances, using a methodology purely based on EIS data without the need for any external electrical potential to trigger faradic responses in the cell [4]. This method permits the rapid quantification of MPs and the differentiation between polluted and virgin MPs, by implementing a simple post-analysis data treatment based on EIS circuit model fitting to obtain the  $R_{dl}$  value.



**Figure 1.** a. Equivalent electrical circuit used to fit the EIS data. b. Nyquist plots of polystyrene dispersed in water pre- (black dots) and post-Pb<sup>2+</sup> ions adsorption at two different  $q_s$  values, namely 480  $\mu\text{g}\cdot\text{g}^{-1}$  (red dots) and 780  $\mu\text{g}\cdot\text{g}^{-1}$  (green dots).

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