Title	Study of the interaction of non-thermal plasma with activated carbon saturated with pefluoroalkyl substances (PFAS) in treatments for the regeneration of the adsorbing material
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Project description:
<u>State of the art</u>: Perfluoroalkyl substances (PFAS) are man-made chemicals which represent a major contemporary environmental and health hazard worldwide. They have excellent properties of stability and inertia which make them ideal components in many processes and products but also persistent pollutants in water and soil, capable of diffusing through great distances and of being taken up by living organisms. Moreover, they are not degraded in traditional wastewater treatment plants but need specific processing stages, typically based on sorption on activated carbon. Regeneration of this adsorption material is generally carried out thermally but entails a considerable loss of carbon, changes in carbon porous structure, and a subsequent decline in the adsorption capacity. Thus, the search for environmentally friendly novel regeneration technologies is urgent and very active.
<u>Objectives and activity</u>: The present project aims at investigating and exploiting the use of non thermal plasma (NTP) for the regeneration of activated carbon through the desorption and degradation of PFAS adsorbed on it. NTP is readily produced by electric discharges in air or other gases at room temperature. It is a source of energetic electrons, which interact with the gas to produce various reactive species capable of initiating a great variety of processes, with no waste of the delivered energy as heat. Preliminary studies ongoing in our laboratory with a prototype reactor based on NTP show promising results in the desorption and degradation of perfluorooctanoic acid and perfluorobutanoic acid adsorbed on granular activated carbon which was submerged in water during the plasma treatment. The PhD project will develop from these encouraging results and extend the research to plasma produced under different experimental conditions (discharge gas, electrode and reactor configuration, ..), to other PFAS and to mixtures of PFAS. A major task of the project will be the characterization of the process through the determination of its efficiency and the study of the interaction of plasma with PFAS and with the adsorbing material. Among the strategies to be employed to this aim are (i) solvent desorption and analysis of PFAS still adsorbed on activated carbon after the plasma treatment, (ii) detection and determination of the plasma produced reactive species, (iii) characterization of the plasma-treated activated carbon, (iv) study of the effects of various experimental parameters on the process efficiency and on the material characteristics. <u>Skills to be acquired and opportunities</u>: The PhD student will use various analytical techniques for the characterization of plasma, the detection of short lived reactive species, like the hydroxyl radical, the characterization of activated carbon, the analysis of the process gas and of the solutions of desorbed PFAS: optical emission spectroscopy, TGA, FT-IR, GC/MS, HPLC-UV/Vis, HPLC/ESI-MS. The PhD student will work in a stimulating multidisciplinary and international envi-

ronment and will have the opportunity to spend a research stage abroad at one of the collaborating laboratories within an established international network (European COST Action CA19110).

Publications:

- M. Saleem, O. Biondo, G. Sretenović, G. Tomei, M. Magarotto, D. Pavarin, E. Marotta, C. Paradisi. Comparative performance assessment of plasma reactors for the treatment of PFOA; reactor design, kinetics, mineralization and energy yield. *Chem. Eng. J.* **2020**, *382*, 123031.
- M. Saleem, G. Tomei, M. Beria, E. Marotta, C. Paradisi. Highly efficient degradation of PFAS and other surfactants in water with atmospheric RAdial plasma (RAP) discharge. *Chemosphere* **2022**, *307*, 135800.