Engineering of two-dimensional nanomaterial layers acting as membranes and reactive electrochemical separation systems

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Many industrial processes produce large amounts of aqueous waste streams (10 – 100 m^3/h), contaminated with, e.g. micro/nanoplastics, organic solvents, and/or oxygen-containing molecules. In view of volume and contaminants, the Reactive Electrochemical Membrane technology offers an economically attractive solution for the treatment of these wastewater streams. Reactive Electrochemical Membranes (REM) rely on a combination of physical separation and electrochemical treatment to convert organic contaminants into non-toxic compounds such as water and carbon dioxide [1]. In this system, the wastewater flows through a porous membrane acting as a physical barrier and subsequently as an active surface (anode) where electrochemically degradation by direct or indirect oxidation occurs. Porous ceramic membranes are widely utilized as support for electrochemical active materials. Sub-stoichiometric titanium oxide-based and B/N-doped reduced graphene oxide-based REM have shown outstanding removal performance but current reported systems are either limited by their small electrochemically active surface areas, large pore sizes, or instability.

Here we will present our strategy to engineer a high-flux, high-porosity REM with a large electrochemically active surface area, using two-dimensional materials and innovative synthesis approaches.

[1] Trellu, C. et al. Electro-oxidation of organic pollutants by reactive electrochemical membranes. Chemosphere 208, 159–175 (2018).