GO-FOR-WATER: Graphene cOmposites FOR advanced drinking WATER treatment

Main area: Nanofluidics based on GRMs
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Abstract

More than 30000 chemicals including drugs, healthcare products and pesticides are daily used by European population and industries. These molecules, called 'contaminants of emerging concern (ECs)' end up in surface water and have been detected even in our drinking water. Consequently, European Commission is recasting the drinking water directive 98/83/EC, by better addressing health risks derived by drinking water consumption, including new contaminants, selected microbial indicators, risk derived by filtering materials. This is pushing joined industrial and academic efforts to develop new technologies able to remove ECs at sustainable costs to replace the state-of-the-art technology mainly relying on multistep treatments including combinations of activated carbon adsorption, selective filters, membrane rejection and disinfection. Among the above-mentioned technologies, only Reverse Osmosis (RO) can tackle multi-contaminants removal with high efficiencies, but it has several drawbacks such as high energy consumption, high water rejection (> 50%), and toxic retentate production. Nanotechnology is expected to lead major advances in drinking water purification field by producing innovative filtering materials with higher removal capacity for a wider range of contaminants. In particular, graphene materials hold great promise with more than 10000 papers from 2017 and several patents on their use for the removal of organic, metal ions and biological contaminants. End goal of GO-FOR-WATER is to develop filters based on graphene oxide (GO) 3D composites for the simultaneous removal of different class of chemicals from drinking water, to be integrated in Point-Of-Use devices (POU), i.e. systems located at sink in houses, school, restaurants, hospital and industries to purify tap water. GO will be combined with selected polymeric scaffolds including natural polymers also deriving from industrial wastes to realize filters. Chemical modification of GO with selected molecules will be also realized to promote wider adsorption selectivity and enhanced removal performances. Processing technologies such as conventional electrospinning, core-shell electrospinning and electrospraying will be exploited to fabricate GO-polymer composites with different hierarchical structures. The removal efficiency of the new materials on a mixture of selected drinking water contaminants of concern, including recently added PFAS and endocrine disruptors, will be assessed and the best performing materials will be integrated into real scale POU filters. Recast of drinking water directive clearly point to protect human health, stressing the importance of microbiological aspects and materials safety, hence biomass release and inactivation by GO selected materials will be tested, as well as biofilm growth in the filter. The long-term stability of the material will be also verified to evaluate its integrity to ensure lack of risk in the water filtered by GO filters. Regeneration mechanisms and processes will be intensively studied to prolong the lifetime of the filters and minimize the production of end-life cartridges. The new filters will be tested in real conditions and compared to state-of-the-art commercial systems in a pilot line already available at CNR assembling commercially available Point-of-Use (POU) models. The success of the project will be ensured by the multidisciplinary consortium with strong expertise on Graphene materials preparation and functionalization, graphene materials multiscale characterization, processing in 3D structures and water treatment technologies. GO-FOR-WATER will also take advantage of already existing industrial collaboration with major players of the water treatment market including POU producers. Therefore, beside fundamental understanding on the structure-property relationships of graphene materials composition and structure the results of GO-FOR-WATER will contribute to the access of graphene to the water treatment market.

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