Fluorinated vesicle-clay composites for PFAs removal from water

"Priority" emerging pollutants in the hydrocycle: microplastics, nanomaterial, PFAs and PPCPs

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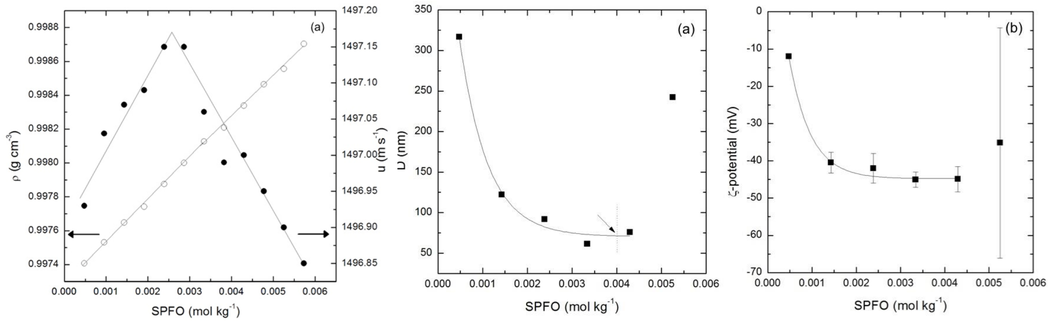
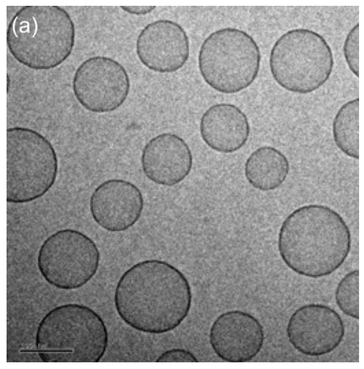
Summary

The use of modified clays for environmental remediation is heavily investigated. Different organic compounds containing fluorine are contaminating the environment and damage human health as well can form complexes with other compounds [1]. Modified clays can be efficient for the removal of ionic and non-ionic contaminants [2]. New bioinspired materials are being developed continuously in order to answer the environmental challenges that nature suffer as a consequence of human activities [3], while water utilities keep optimizing processes and cost and using new technology developed elsewhere [4]. Micelle-clay composites have been used for environmental remediation and for the removal of organic pollutants from water [2,5]. The removal of fluorinated compounds from water and soil is difficult. Fluorocarbons can form self-assembled structures and membranes that are at the same time hydrophobic and lipophobic [6,7]. In this research we investigate the use of hybrid catanionic fluoro-hydrocarbon surfactants, known to form membranous vesicular structures to combine with clays to prepare fluoro-vesicles-clay composites for the removal of fluoro-compounds from water.





(a) Purpose or objectives and status of study or research hypothesis
We work to develop clay filters based on fluorinated catanionic vesicles for the removal of key PFAs pollutants from water. We use a modified method based on clay-based composites characterized at the Molecular-Scale Biophysics Research Infrastructure (MOSBRI) under the project (MOSBRI 2022-101). This project has received funding from the European Union's Horizon 2020 research and innovation program under grant agreement No 101004806. The lessons learned on that project are now used for our new approach for fluorinated-based filters. The protocol used here for the preparation the clay composite was analogous to the one reported in the MOSBRI 2022-101 project substituting the nanocellulose for the solution of hybrid fluoro-hydrocarbon catanionic vesicles.

(b) Key issue(s) or problem(s) addressed
Many Fluorine-based pollutants cannot be absorbed directly in clays without modification. The chemical nature or Fluorine based compounds made them difficult to remove, hence persistent in the environment. We developed modified clays using catanionic vesicles (that contain fluorocarbon chains) for the removal of Fluorine-based pollutants from water. We aim to develop cost-effective filters easy to recycle ensuring sustainability.
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c) Methodology or approach used
The clay is being modified at different concentrations of a catanionic surfactant able to form vesicles with semi-fluorinated counterparts that become integral part of the clay. The modified clay and removal efficiency is characterized by different techniques. The removal efficiency will be investigated at the university facilities from our collaborators in Copenhagen. Cry-TEM and AFM images of the pure vesicles are shown as example. The modified clay was dried and used for the removal of a short chain PFA.

(d) Results and conclusions derived from the project
The modified clay is being characterized and experiments will be provided to confirm the optimal F-vesicle concentration and ratio of Fluorinated vs Hydrogenated counterpart to ensure a functional clay modification for the removal of FPAs. Complementary studies are being done using different techniques (FTIR and UV) to assess the removal efficiency of different samples under investigation as a prove of concept (not shown here). Preliminary test show the adsorption of PFAs into the F-vesicle-clay composite. Density, sound velocity as well as size and zeta potential of the vesicles are show for different PFA concentration.

(e) Policy implications of the project relevant to the selected conference theme, theory and/or practice
We aim to provide with a cost-effective filter that can be reused may times for the removal of small amounts PFAs to maintain clean water bodies. If regulation requires the removal of small amounts of PFAs we will be able to provide solutions at a cost-effective.). More experiments need to be done to prepare a functional filter.

Acknowledgments

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