Empa
Materials Science and Technology

Nanostructured materials for multi-viral filtration

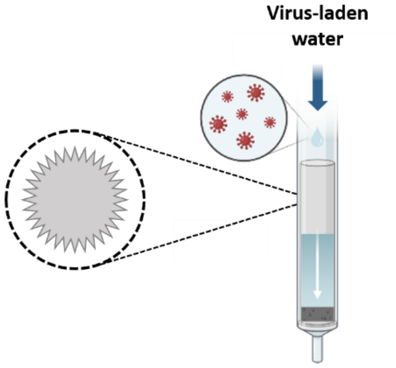
Human activities and climate change are increasing the contamination risk posed by water-borne viruses to global water systems[1]. Conventional approaches for viral filtration from water, such as disinfection (e.g. via chlorination), often require centralized infrastructure with expert monitoring[2]. Unfortunately, these technical strategies are often inaccessible to underdeveloped or remote communities, and lack the flexibility to deal with emergencies such as natural disasters[3]. In these instances, simplified approaches such as gravity-based depth filtration are better suited to obtain clean drinking water[4].

Depth filtration systems consist of a porous filtration medium to adsorb contaminants from the filtrate, differing from standard filtration techniques which utilize e.g. size exclusion to remove suspended materials at the membrane surface only. A common example of such filters are packed beds of granulated materials, such as the activated carbon found in Brita® water filters. In comparison to other membrane-based technologies, pressure drops are much lower for depth filtration, resulting in reduced energy requirements (if any) and thus lower costs. The driving pressure can be applied via an external pump, or even via the use of hydrostatic pressure, i.e. from the weight of the water to be filtered.

Despite their advantages, state-of-the-art depth filters still have some intrinsic limitations which are yet to be overcome. Viruses are particularly problematic for traditional depth filters due to their small size, requiring highly adsorbent materials which are also capable of processing large flow rates. High surface area nanostructured materials present a promising solution to this challenge[5], however, they are typically characterized by high fabrication costs, ruling out their real-world application. Furthermore, metal ion leaching from such nanomaterials poses significant health risks[6] which are often not addressed in the academic literature.

At the High Performance Ceramics lab at Empa, we have performed preliminary tests identifying a promising high surface area material for the removal of viruses and bacteria from water. The nanostructures are obtained from cheap and commercially available raw materials, with intrinsic beneficial properties for water-filtration. In collaboration with OST (Rapperswil), we are now investigating the viability of this material as the basis for an advanced filter system for multi-viral filtration (ARMFUL), with the goal of commercialization in the medium-term.

We are looking for a motivated MSc. thesis student to take part in this exciting multi-disciplinary project encompassing aspects of: microbiology, chemical synthesis, colloidal science, and chemical engineering, to help develop and test filters obtained with nanomaterials. You will work under the daily supervision of a Postdoc to optimize the synthesis of the nanostructured material, help design the filtration system, and investigate the range of possible operating conditions for virus filtration. This project is the culmination of a long-standing research line at Empa, and we expect that your work will form part of a future publication. Subject to the performance of the final filtration system, we hope to develop a spin-off if the product is deemed commercially viable.



If you have a curious mind, an appetite for challenges, and the willingness to learn new skills on the job, we would love to hear from you! For further information, please contact Max Bailey (maximilian.bailey@empa.ch)

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