Abstract Cornet project:

Development of new antibacterial functionalised textiles and 3-D-printed filters for process water treatment (DAF3D)

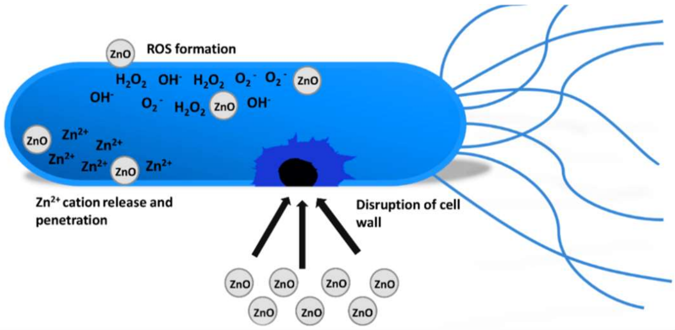
Water is vital for life and key for essential industrial processes. Due to the increasing consumption and contamination, the access, treatment and safety of water is becoming challenging and costly. Therefore, new technologies have to be developed to ensure sustainable protection and safe access to water for both human consumption and industrial use. The DAF3D project aims to develop innovative and sustainable antibacterial functionalised textiles and 3-D-printed filters for water polishing and disinfection. The expected application is centred on production and reusability of process waters from diverse industrial sectors and households. For instance, in the chemical and food industries, water recycling is enforced and cost-saving but biological safety is a major concern. The antibacterial functionalised textiles and 3D printed filters are a promising solution for these issues and can be implemented in a wide diversity of applications, configurations and dimensions.

Innovative disinfecting filter materials will be developed based on modified textiles with antibacterial materials, such as zinc oxide (ZnO) structures doped with Ag, Cu or Al. These new antibacterial textiles are capable of generating in situ highly reactive oxidizing species, which can degrade a wide range of organic substances, including microorganisms. It has been shown that ZnO, with its antibacterial and antiviral effects, can be used for water decontamination. Species generated by ZnO break through the cell wall and then cause irreversible damage to the cell, leading to cell death.

By using additive manufacturing technologies, filter materials with precisely defined structures can be produced. Only this manufacturing process makes it possible to optimise the flow of water through the filter materials in a way that was previously impossible. This would not only save energy, but the design of filter systems would also have to withstand significantly lower mechanical loads due to pressure. To enable sterilization while water flows through the filter, a material is needed that can be processed in 3-D-printing, has a sterilizing effect and does not contaminate water. A material with these properties is not yet available on the market, which is why it have to be developed within the project. At the end of the project, the compositions of the antibacterial agents will be incorporated into the thermoplastic compounds in different concentrations using a plastic extruder and subsequently a filament for 3-D printing will be produced.

These antibacterial filters will be tested for the degradation of microorganisms such as E.coli and others coliforms individually as well as in combination. A pre-treatment of the process water will be investigated and added before the filter depending on the process water used. Afterwards, these filters will be tested with different types of industrial or domestic pre-treated process waters. First, raining and well waters will be treated in batch to evaluate the bacteria lower concentration limit that can be reached with that technology. In parallel, some process waters will be characterized in order to validate the possibility water reuse in some industrial sectors. For example, waste water from a cleaning truck industry could be reused as first pre-cleaning water for others truck washing.

The ultimate aim of the DAF3D project is to validate a polishing and desinfection filtration step for production or re-use of process waters using a combination of functionalised textiles and a 3D printed filter. Thus, the DAF3D project can have a significant impact on enabling sustainable treatment and safe access to water, which is a well-known resource but susceptible to contamination and source of critical health and environmental problems.



Schematic presentation of different mechanisms of antimicrobial activity of ZnO nanoparticles