

The **research material** analyzed in this project will be a novel nanocomposite prepared in the form of a nonwoven fabric: polylactide (PLA) containing embedded grains of functionalized SBA-15 mesoporous silica. The material is shown in Figure 1. PLA in the form of fibers acts as a mechanical carrier and the main filtering material. Thanks to its weave structure, it will enable mechanical filtration of air and liquids, while also providing a spatial framework for the active functional nanomaterial: SBA-15 with copper propyl phosphonate molecules, separated and precisely located inside the pores (hereinafter referred to as SBA-POO<sub>2</sub>Cu). Thanks to this spatial arrangement of active molecules, being catalytic centers, the material acts as a single-atom catalyst (SAC), generating reactive oxygen species (ROS). The use of mesoporous silica with a huge specific surface area as a template for active groups gives the resulting SAC enormous catalytic efficiency. Its local action allows for the elimination of harmful microorganisms: bacteria, fungi, and viruses, as demonstrated by preliminary studies (see also Figure 1). Thanks to its composite structure, we are able to obtain a material intended for the production of modern air filters (also for liquids) with a two-stage action: mechanical filtration would retain pollutants and some harmful microorganisms, while the action of the active nanomaterial would eliminate the remaining pathogenic microorganisms. An additional advantage of this solution would be the elimination of biofilm forming on filters, which is a secondary source of infection. This is extremely important, especially in view of the recent COVID-19 pandemic.

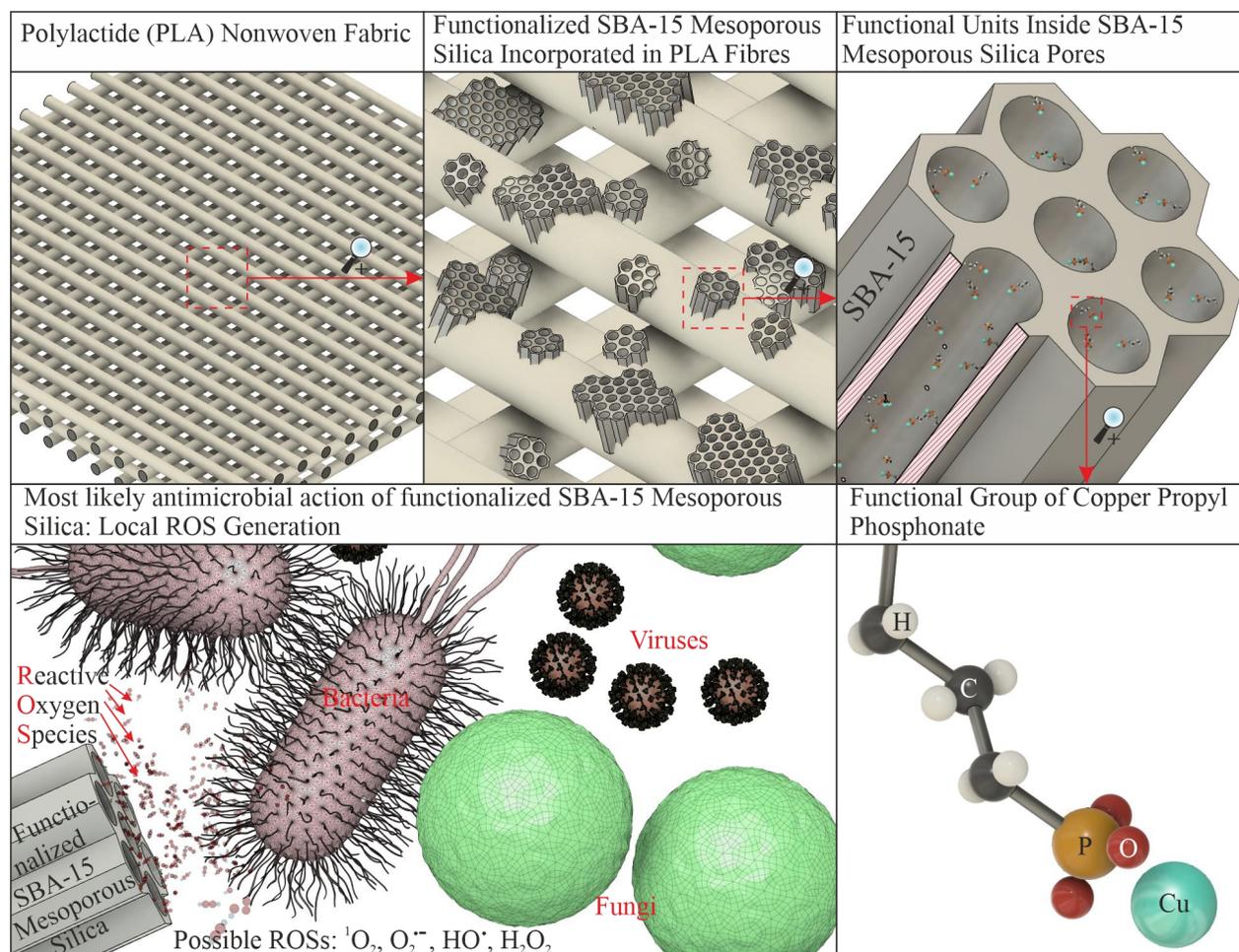


Figure 1: Schematic presentation of the material being designed and an illustration of its antimicrobial activity.

It should be emphasized that the active material (SBA-POO<sub>2</sub>Cu) itself has been precisely designed as a single-atom ROS catalyst and synthesized as such using molecular engineering and nanotechnology. This allowed the obtaining of a material that is very interesting, from a scientific point of view. The preliminary test results were so remarkable that they surprised us. This raised many scientific questions that we would like to answer in this project.

The **aim of the project** is to thoroughly investigate the mechanical, physical, biological, and catalytic properties of the obtained nanocomposite. The planned research will allow us to determine the suitability of the proposed materials for filter construction, but above all, to fully understand the phenomena occurring in the material and understand its properties, which are most likely caused by the catalytic generation of ROS by functional groups. **Our multi-faceted approach to understanding how our material generates radical species, and ultimately aim to provide a deeper understanding of how safer materials can be designed for biomedical and environmental applications as an important component of sustainable nanotechnology.**

We expect as outcomes of the project implementation: at least six scientific publications in international journals with high Impact Factor, patent proposal concerning the preparation technology, and the report on a new class of biocidal materials, describing their properties and the applicative potential.