Defence-related Research Action - DEFRA

ACRONYM: NANO-PROTECTION

Title: Nanofibre-based aerosol layers for enhanced CBRN protection

Duration of the project: 1/12/2025 - 01/03/2030

Key words: CBRN protection, electrospun nanofibres, metal–organic frameworks (MOFs), self-decontaminating fabrics, oleophobic coatings

Budget: 1.829.000 €

of which RHID contribution: 1.073.000 €

PROJECT DESCRIPTION

The NANO-PROTECTION project aims to develop a new generation of protective fabrics for chemical, biological, radiological and nuclear (CBRN) defence applications by integrating functionalised electrospun nanofibres into the aerosol filtrating layer of protective suits. The project introduces a major technological shift from conventional passive systems, which rely on thick multilayer constructions and activated carbon for adsorption, towards an active and multifunctional fabric capable of (i) neutralising toxic agents simultaneously, (ii) filtering aerosols and (iii) repelling oily contaminants within a single lightweight and breathable layer. This new approach directly responds to the increasing complexity of CBRN threats, including aerosolised agents and emerging compounds such as Novichok, and addresses the limitations of existing suits that remain heavy, uncomfortable, and environmentally unsustainable due to their dependence on PFAS-based repellents.

The innovation and objectives proposed by NANO-PROTECTION lie in the integration of metal–organic framework (MOF)-based functionalised nanofibres, which will provide active decontamination by catalytically degrading chemical warfare agents (CWAs) such as sarin gas and VX into non-toxic products. At the same time, the specific morphology and orientation of the electrospun fibres will ensure high filtration efficiency against aerosolised particles in the range of one to three micrometres, while maintaining excellent air permeability and comfort. An additional oleophobic surface treatment will enable partial oil repellence reducing the dependence on perfluorinated chemicals, thus reducing environmental impact and aligning the project with the broader sustainability objectives of European and NATO defence research programmes. Together, these four functionalities (breathability, active decontamination, aerosol filtration and oil repellence) will be combined in a single engineered composite layer, compliant with the operational requirements and technical specifications set out in NATO AEP-38 and STANAG 4548.

The project will be carried out through a close collaboration between industrial, academic and defence research partners. Seyntex, a leading Belgian manufacturer of protective textiles, coordinates the project and will oversee fabric integration, garment prototyping and manufacturability assessment along with the technical support for the selection and supply of MOFs. Materia Nova will focus on material development, including the synthesis and surface functionalisation of MOFs, optimisation of electrospinning processes and detailed material characterisation. The Defence Laboratories Department (DLD) will perform validation and benchmarking of the developed fabrics under realistic CWA simulation conditions using permeation, aerosol and laundering tests following NATO standards. The work plan is structured into four main phases: (i) Material design and functionalisation, (ii) optimisation of fibre structure and filtration properties, (iii) integration into CBRN prototypes, and (iv) final evaluation of performance, comfort and durability in laboratory and field-relevant conditions.

For Belgian Defence, the NANO-PROTECTION project represents a significant strategic opportunity to enhance operational readiness in the face of both traditional and emerging CBRN threats. The resulting protective system will combine lightweight comfort with superior safety by extending the duration of field missions and reducing risks associated with secondary contamination. The PFAS-free design will anticipate upcoming environmental regulations and contribute to Defence's sustainability commitments. In addition, the establishment of new experimental setups at DLD for the characterisation of advanced CBRN textiles will strengthen Belgium's internal testing capabilities and reduce dependency on external laboratories. By providing validated data on protection performance, thermal comfort and durability, the project will also inform procurement and capability planning in alignment with NATO and EU Defence Research and Technology priorities.

By the end of the project, NANO-PROTECTION will deliver a validated nanofibre-based aerosol layer and full-scale prototype CBRN suit demonstrating enhanced comfort and protection compared to current systems. The outcomes will include detailed scientific reports and peer-reviewed publications on nanofibre functionalisation, CWA degradation mechanisms, and filtration performance. The project will also provide technical documentation supporting material testing and performance evaluation according to NATO AEP-38 standards. Short-term valorisation will focus on transferring the developed knowledge to Belgian Defence and industrial partners, while medium-term valorisation will explore opportunities for further research and application of the technology in defence-relevant contexts.

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