EUROPEAN DEFENCE AGENCY

Fact sheet

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STILE: Smart TextILEs in Defence

Smart Textiles are a new generation of materials and systems with interesting multifunctional properties which, given their ability of being integrated into uniforms and platforms, have drawn the attention of defence stakeholders.

EDA has incorporated Smart Textiles into the Strategic Research Agenda of the Materials CapTech.

In 2018, EDA launched a project, called STILE, "Smart TextILEs in defence: looking at the soldiers of the future". This project was assigned to a consortium led by the Spanish AITEX research institute, in collaboration with two Portuguese organisations, CITEVE and INEGI.

The STILE project was designed to lay the foundation for a European Multifunctional Smart Textile focusing on defence specificities and, specifically, tackling aspects of functionality integration, comfort and lightweight.

Within the scope of this project, two objectives were defined:

» to develop a credible roadmap, with the final goal of establishing how to pass from the current state of the art to a full system that integrates several functionalities in a textile substrate;

» to come up with a proof of concept, integrating various functionalities:
- signature management
- monitoring of environmental parameters and CBR threats
- flame retardancy
- water and dirt repellence and anti-mosquito solution
- physiological monitoring
- temperature regulation
- communication and wireless exchanging data.

Roadmap

As regards the technology roadmap, the aim was to ensure it can be used by EDA in the planning of R&D activities related to smart textiles technologies in the medium and long timeframe, bridging the existing gaps between the current state of the art and a complete system that integrates different functionalities in a single textile substrate.

The study presents information related to the R&T needs, technologies, challenges involved in overcoming the R&T needs, overall implementation recommendations, planning and budget estimations, market trends that might influence the evolution of smart textile technologies, business models applicable to the military sector, technological applications deemed relevant for the military sector, a discussion around a use case scenario with the purpose of understanding the functioning in military scenarios, standardisation needs and issues, risks and contingencies foreseen for the implementation of the roadmap.

The methodology that supported the preparation of the roadmap was based on the technical knowledge of the consortium members and the collection of data coming from multiple sources:

» **State of the Art (SoA).** It contributed to the understanding of the development stage of the various technologies related to smart textiles.

» **Comprehensive bibliographical review.** An extensive review was performed on several publications to complement and update the topics and analyses from the State of the Art.

» **Technology Foresight Workshop on Smart Textile Technologies.** A foresight workshop was held to tap into experts' knowledge on novel ideas and breakthrough technologies. The objective was to identify technologies and applications, in the form of a list of R&T needs and technologies deemed relevant to address those needs.

» **Survey.** A survey was prepared after the first version of the roadmap and distributed to Materials CapTech experts, in order to complement the compiled information.

» **Interactions with experts.** Dedicated meetings were held with members of the CapTech Materials & Structures in order to support the definition of a number of smart textiles use case scenarios for the defence sector.

Simulation

Two simulation models were developed to evaluate the main concepts regarding the thermal protection capacity of the garment and the thermal signature under different ambient conditions.

Three exposure scenarios were defined and simulated in order to evaluate the fire protection capacity. A FEM (Finite Element Method) model was developed to study the thermal protection capacity of the clothing assembly. In the same way, five exposure scenarios were defined and simulated with the objective of analysing the thermal signature.

This first simulation model is supposed to be the basis for advanced methodology in smart textile industry to respond to the sophisticated requirements before the fabrication phase.

Proof of concept

A proof of concept was developed , integrating in the same smart multifunctional textile combat system the seven following functionalities:

Signature management. A textile with specific properties has been developed, by means of thermochromics formulations, studies of colour fastness to light and measurements of colour coordinates, in order to provide a multispectral camouflage, with special focus on visual, Near InfraRed and thermal spectra, aiming at decreasing the visibility of the soldier in combat zones, in both static and moving positions.

Monitoring of environmental parameters and CBR threats. Several specific sensors were integrated in the combat uniform in order to detect the presence of hazardous agents in the environment surrounding the soldier.

Improved mobility. The smart multifunctional textile system was designed and produced taking into account parameters such as ergonomics, homogeneous distribution of weight, wearers' comfort, modularity, freedom of movement, and functional properties based on a body mapping study aiming at defining specific functionalities for each body area (such as flexibility, compression, and ventilation areas). Regarding the wearable electronic components, the most flexible, light and miniaturized elements were selected.

Flame retardancy, water and moisture repellence and anti-mosquito solution. Textile fibres and materials with flame retardant properties were selected, and the rest of the components were positioned in specific compartments, to avoid exposure to heat and flame. Other functionalities, such as water and moisture repellence and anti-mosquito were incorporated using the most innovative functional finishing technologies, by means of thermochromics formulations, colour fastness tests to washing cycles, and colour fastness tests to light.

Physiological monitoring. The monitoring of certain physiological parameters of the soldiers was carried out by means of specific sensors located in the inner layer of the smart multifunctional textile system, in contact with the body skin. The special stretching and flexible properties of the electrodes enabled to obtain a comfortable solution, without the need of hard and rigid elements. Thus, sensors able to measure the heart rate were integrated in the textile substrate through the use of conductive textiles and printed electronics techniques.

Temperature regulation. A system capable of regulating the thermal comfort of the soldier, adapting to the weather conditions and considering the physical activity carried out, was incorporated to the combat uniform. This solution included both heating and cooling effects.

Communication and wireless exchanging data. All the sensors integrated in the smart multifunctional textile system are capable of sending the registered data via wireless networks, enabling the monitoring of different parameters related to the state of the soldier in the combat field. In the same way, the various electronic solutions can be adjusted, activated or deactivated from the control centre located in a smartphone. The information is shown by means of a mobile app that was ad hoc developed to show the valuable information in a user-friendly and intuitive way.