



Lightweight, flexible
and smart protective
clothing for law
enforcement personnel

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Smartpro: Short Description

The concept of SMARTPRO lies in the development of lightweight and smart protective clothing, incorporating smart functionalities and designated for law enforcement authorities.

Up to now, research on the protective gear of this group concentrated on the ballistic properties of the body armour. However, in spite of the improvements, modern body armours still have some of the same drawbacks as the old ones, as they are mostly heavy, bulky and rigid. Therefore, they limit the wearer's mobility and agility and are impractical for use on joints, arms, legs, etc. Moreover, body armours have traditionally been de-

signed to protect the wearer against ballistic threats and thus, they provide only a limited level of protection against knives, sharp blades or other sharp-tipped weapons. Recent studies, however, reveal that stab and puncture have become a main cause of police officers injuries. Therefore, there is an obvious need to develop materials that combine stab and ballistic protection, while retaining their flexibility and low weight.

In this context, SMARTPRO aims to develop optimized ballistic textiles (both woven and spacer knitted fabrics) and apply innovative surface treatments (e.g. shear thick-

ening fluids, ceramic coatings) to improve their performance on an areal density basis. Thus fewer fabric layers will be required, which is expected to result in increased flexibility and reduced weight of the armour. Main parameters to consider also include the physiological comfort and ergonomic design. Additionally, smart functions, including positioning systems, will be integrated to further increase the efficiency of the body armour, eventually leading to reduced casualties.

Finally, innovative solutions are proposed for the protection of vulnerable body parts other than the torso.

Project's ID:

- SMARTPRO is a collaborative project under the 7th Framework Programme (call identifier - FP7-SEC-2013.1.4-1).
- The starting date of the project was April 1, 2014 and the duration is 42 months.
- The consortium is composed of 10 beneficiaries from 5 EU countries (Greece, Spain, Italy, Germany, UK).

Goals of the project

The distinct Scientific and Technological objectives of the project are summarized as follows:

- Development of flexible and lightweight ballistic and/or stab resistant textile panels.
- Reduced maintenance requirements.
- Increased awareness.
- Comfort and user acceptance.
- Realization & evaluation of prototypes

Approaches to objectives

Development of flexible and lightweight ballistic and/or stab resistant textile panels

- Optimization of composition and structure of ballistic and/or stab resistant textiles for specific threat types/levels
- Application of alternative treatments to increase the ballistic and/or stab protection provided by textiles on an areal density basis.
- Assembly of ballistic and stab-resistant textile layers in order to maximize the level of protection while keeping the weight and cost of the panel as low as possible.
- Development of fish-scale type outermost protective layer to absorb the first impact.

Reduced maintenance requirements

- Functionalization of the outer fabric of the body armour to induce self-cleaning and de-polluting properties.

Increased awareness

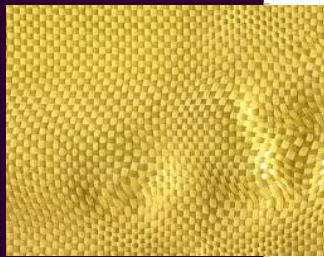
- Development and integration of smart solutions, including wearable GPS, ECG, temperature and gas sensors.

Comfort and user acceptance

- Use of 3D (spacer) fabrics for reduced thermal stress
- Optimized design considering modularity and ergonomic requirements of end-users.

Realization and evaluation of prototypes

- Manufacture of prototype body armours, including protective gear for body parts other than the torso and their



Protective textiles: Composition & structure

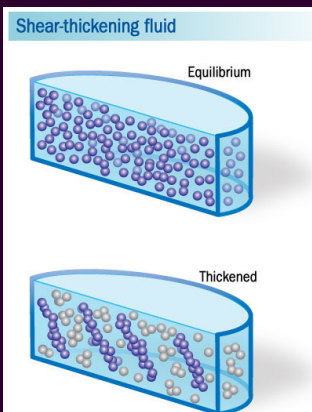
Handgun bullets that deform under impact are stopped effectively by flexible textile structures. Kinetic energy is absorbed by the fibers primarily as tensile energy and to a smaller extent as bending and inter-fiber/yarn frictional energy.

High performance fibers such as Kevlar®, Spectra® and Zylon® are commonly used for ballistic armour.

In order to enhance impact energy dissipation, the composition and structure of woven protective fabrics

will be optimized accordingly.

Moreover, spacer (3D) knitted fabrics designated for ballistic applications will be designed and realized using high performance yarns.



Surface treatments of protective textiles

In order to improve the flexibility and the performance-to-weight ratio of body armours, alternative surface treatments will be developed and applied on protective textiles. These include:

- Treatment of protective

textiles with shear thickening fluids.

- Treatment of protective textiles with ceramic coatings by thermal spraying.
- Treatment of protective textiles with dilatant powders by electrostatic

powder spray gun.

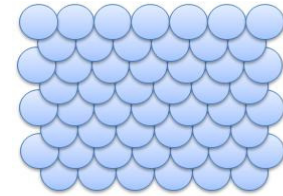
- Deposition of carbide nanoparticles on protective textiles.
- Coating of aramid fabrics using cross-linkable side functionalized aromatic polymers.

Fish scale type composites and nanowebs

Nature can serve as a significant source of inspiration for new and alternative engineering designs. Catching up with the recent trend of mimicking nature, we plan to imitate fish scale structure as a part of the protective wear. Fish skin has remarkable mechanical properties: lightweight, compliance, resistance to penetration; all of these in

context of an ultra-thin structure.

Furthermore, innovative hybrid structures made of synthetic polymer nanofiber composites will be fabricated and evaluated for ballistic protection applications. Systematic investigations will be conducted on electrospinning of polymer nanofibers and impregnation of nanofibers into resins.



Development & integration of smart systems

Although previous research projects have valuable insights to smart systems including positioning systems, health monitoring systems and sensors, none aimed at law enforcement applications, like use in body-worn armour which have unique requirements.

Textile antennas utilized in body-worn armour are required to be completely integrated into the garment and not to present any weak spot. The ability to manufacture body armour with integrated

textile antennas in a roll-to-roll process guarantees an automated and therefore fast production.

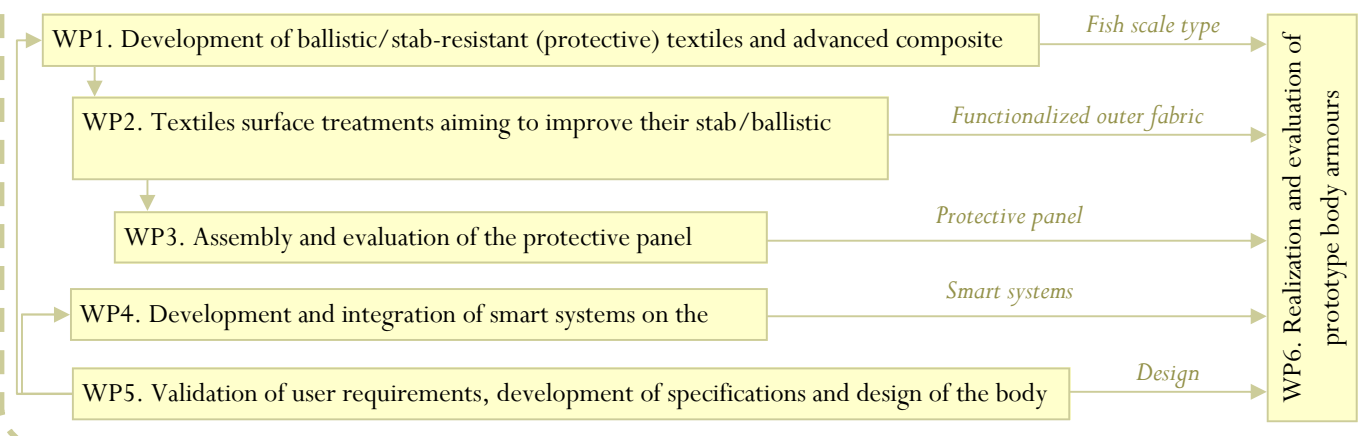
Furthermore, operability must be ensured in law enforcement applications no matter how the wearer moves or is positioned.

A supplementary aim of the project is to implement a smart system into body-worn armour which automatically detects injuries to the wearer and then transmits the GPS position of the wounded law enforcement

personnel. This functionality would inform support personnel of the location of the injured and guide them as quickly as possible to the appropriate position.

Finally SMARTPRO will also focus on the advancement of novel nanomaterials structures and geometries for application in wearable sensing devices. In this context metal oxide semiconductors (MOS) will be investigated for gas sensing measurements.

Smartpro methodology



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- **Department d' Interior—Generalitat de
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www.smartpro-project.eu

Want to join the Group of Interested Parties?

In order to get an appropriate feedback from a large panel of end users, but also of possible actors that may be interested to participate to the exploitation of project results, a “Group of In-

terested Parties” will be created, featuring representatives of industrial organizations, end-users and public procurement authorities.

The representatives of the organizations participating in this Group will be periodically updated with the project progress, e.g. by receiving newsletters and by participating in targeted meetings and Workshops, and will therefore promote the awareness of the project through their member and contacts all over Europe.

If you are interested in joining the INTERESTED PARTIES GROUP please contact:

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