

European Good Practices in New materials and new applications

Advanced ballistic materials and products

Marcin H. Struszczyk

6th RESET Seminar on
“New materials and new applications”
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Advanced ballistic materials and products

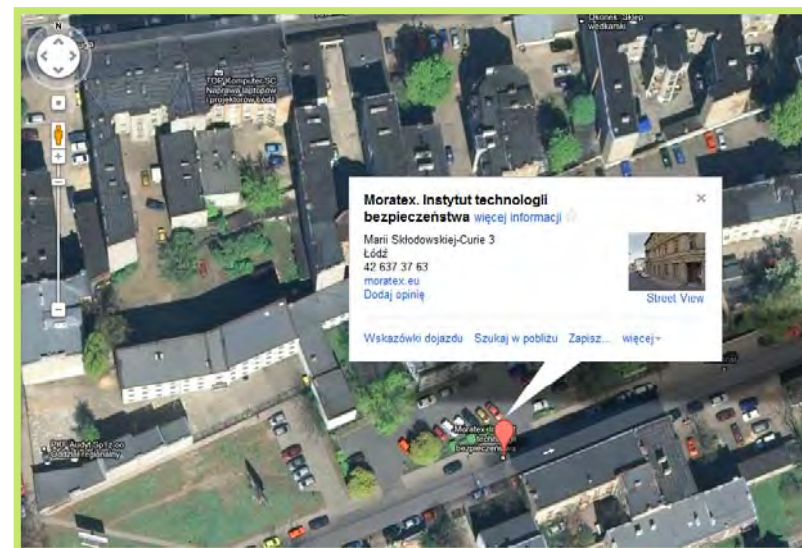
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- Institute of Security Technologies „MORATEX” is a research institute supervised by the Minister of Interior and Administration.
- The subject of our activities is performing the research and development works to develop new technical and technological solutions in the field of manufacturing the equipment and individual means for the protection of human life and health as well as to transfer them into industrial practice.
- MORATEX is also a notified body No. 1475 under the directive 89/686/EEC regarding the personal protection equipment (PPE).



Google Map



No. 31/MON/2015
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No. 49/MON/2016



No. 33/MON/2015



AC 097



AB 154
AB 155
AB 1573



Winner of Grand Prix
DIAMOND Award
The Association of Purveyors
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BALLISTIC PROTECTION

PROTECTION VESTS

HEAD PROTECTION

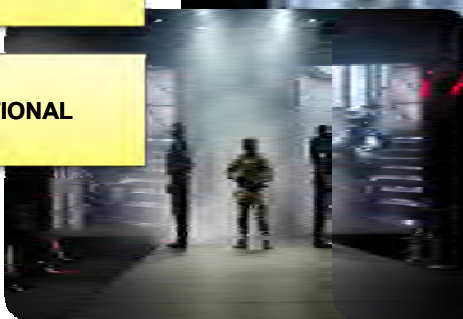
BALLISTIC SHIELDS

BODY PROTECTORS

SPIKE- AND KNIFE RESISTANT

**FRAGMENTS AND BULLETS
RESISTANT**

MULTIFUNCTIONAL





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Main criteria of the design in security and military domains

- High resistance, high-strength;
- Susceptibility to aim of use;
- Performance (high- and multifunctionality);
- Susceptibility and possibility to relocate (easy, economic transport);
- Ease of maintenance and repair.

Ch. Fiell, P. Fiell, Design, The history of design, Design for war, Wydawnictwo Arkady, ISBN 978-83-213-4865-0, Warszawa, 2015, 325-337



http://technologie.gazeta.pl/internet/1,104530,16947774,Pancerze_helmy_kamizelki_kuloodporne_z_okresu_I.html [2014-11-16]



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Gap analysis (market needs):

- optimization of the hybrid ballistic composites processes manufacture by significant reduction in the numbers of the process stages supporting by screening of the ballistic textiles with following modification of their surface behaviour;
- deeper implementation in process of the customization and/or personalization of the advanced protective products the ethical/human and gender issues;
- necessity to develop the materials and/or technologies resulting in product with reduced mass with remaining the ballistic protection level or increase of the ballistic protection level with remaining mass and reduction in BABT risk.

The application of the textiles in ballistic protection is limited by required and documented resistance on the environmental factors, such as humidity, temperature gradient, biological factors, etc., prolonged lifetime of the final products and the ergonomics.



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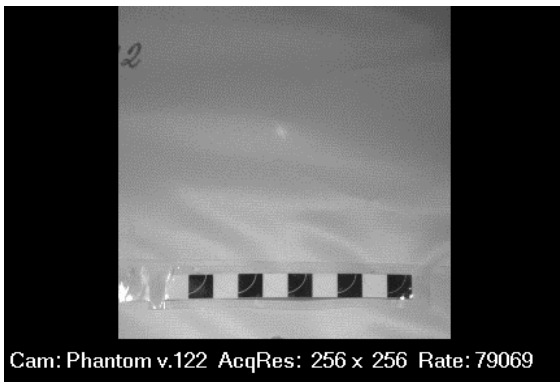
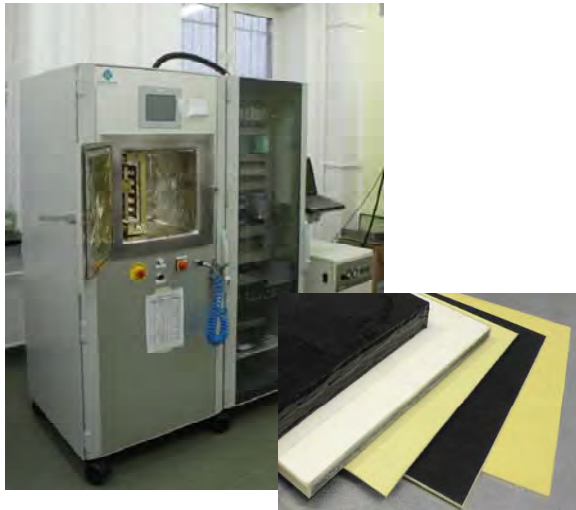
Research activities realized in MORATEX were focused on:

- **Development of functionalization of the textiles materials applicable in ballistic protection resulting in the increase of the resistance against the external factors as well as implementation of the technological possibility to design low-mass ballistic composites – presently TRL VI;**
- **Development of the new hybrid composite materials based on the fibrous materials with combination of the ceramics for improving the ballistic performance and reducing the mass affecting ergonomic and safety – presently TRL IX;**
- **Development of the procedure of the body-fitting ballistic protections using 3D-body-scanners affecting the ergonomics of the final protections – presently TRL VIII.**



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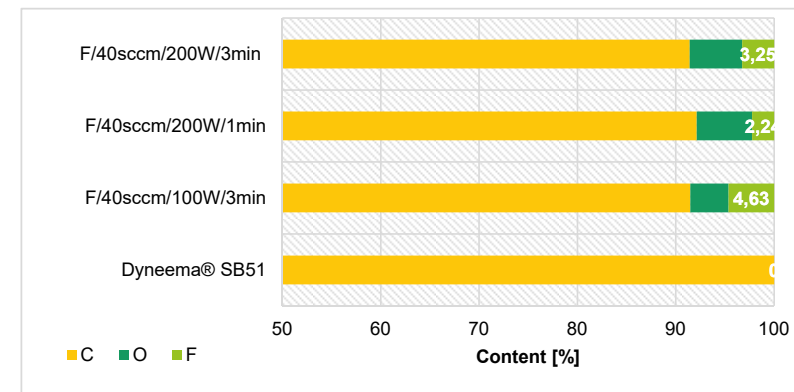
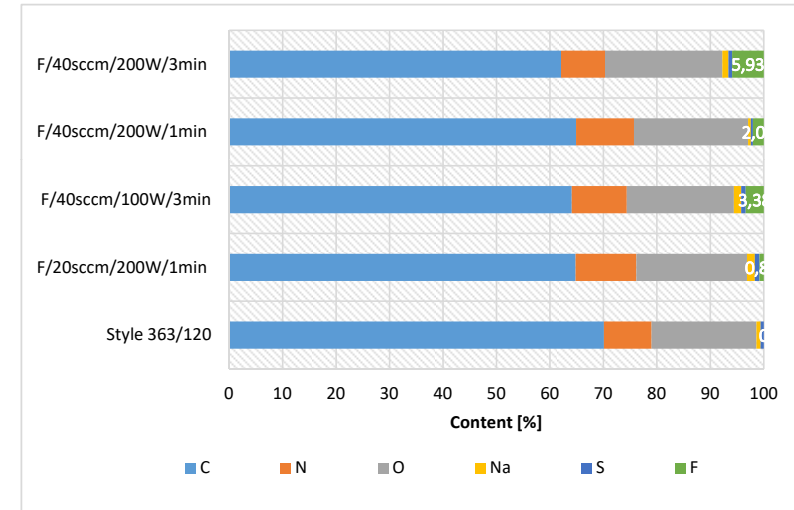


Development of functionalization of the textiles materials applicable in ballistic protection resulting in the increase of the resistance against the external factors as well as implementation of the technological possibility to design low-mass ballistic composites

The modification of ballistic textiles with the use of PACVD technique as elaborated in this study is a promising technology for the performance and safety improvement of ballistic body protectors, such as ballistic vests as an example. The safety increase is not at least the result of the significant increase of the stability of the surface structures obtained.



Struszczyk MH, Urbaniak-Domagala W, Puszkarz AK, Wilbik-Halgas B, Cichecka M, Sztajnowski S, Puchalski M, Miklas M, Krucinska I. Structural Changes in Fibrous Ballistic Materials During PACVD Modification. FIBRES & TEXTILES in Eastern Europe 2015; 23, 6(114): 102-115. DOI: 10.5604/12303666.1167426
The research was supported by the National Science Centre under the research project No. N N508 629940 „THE STUDIES ON THE FUNCTIONALISATION OF BALLISTIC MATERIALS





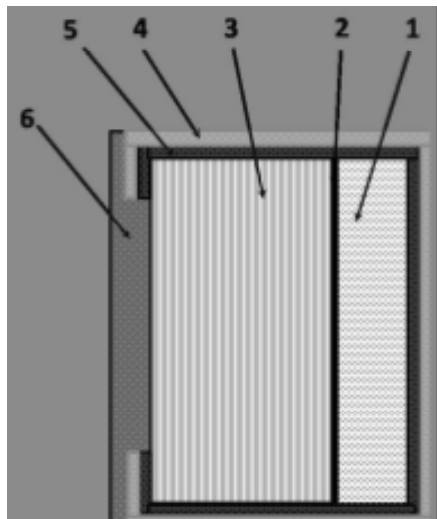
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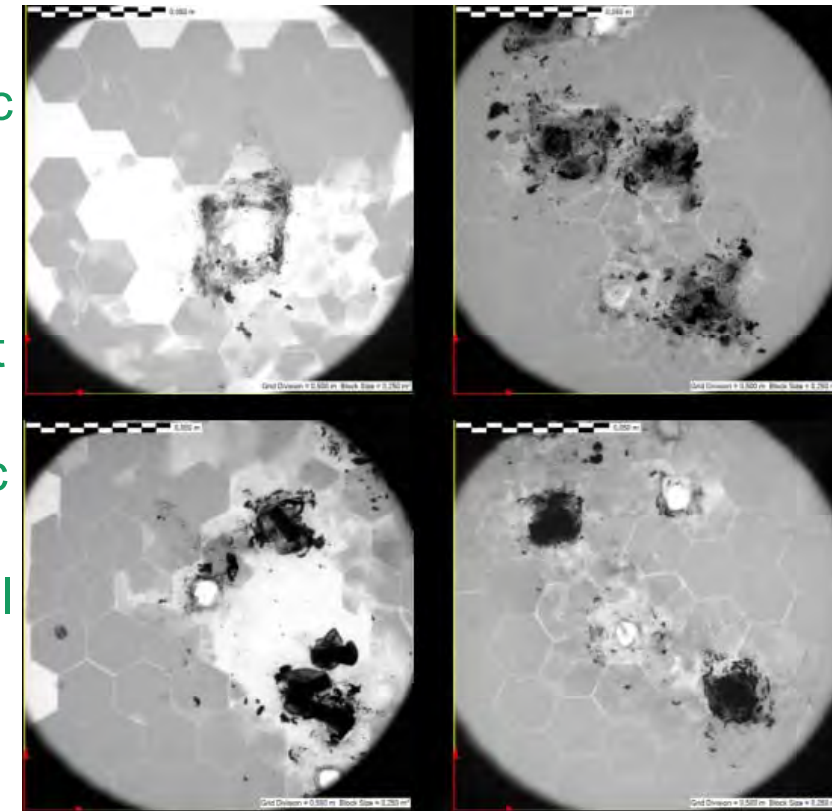
Development of the new hybrid composite materials based on the fibrous materials with combination of the ceramics for improving the ballistic performance and reducing the mass affecting ergonomic and safety



New concept of hybrid ballistic materials consisting in a ceramic and fibrous composite covers the idea of the appropriate selection of materials layers for armour yielding an improvement in the ballistic behavior of the final multilayered, hybrid ballistic armour. Suitable selection of the types of fibrous materials as well as the shape, thickness and confinement of the ceramic should affect the ballistic properties of the resultant multilayered, hybrid ballistic armour.



Design of system confinement of hybrid ceramic - multi-layered UHMWPE composite armour. Schematic design of the armour system (a), technical textile mesh (b), foamed material (c), p-aramid-phenolic prepreg (d);
1 – ceramic, 2 - silicone adhesive 3 - polyethylene composites 4 - the technical textile mesh, 5 - p-aramid-phenolic prepreg, 6 - foamed material



RTR photos of unprotected hybrid ceramic - multi-layered UHMWPE composite armour (a), (c) and armour protected with the system confinement after ballistic testing (b), (d); a, b) multi hit/ 5.56x15 SS109; c), d) multihit/7.62x39 PS



Fejdyś M., Kośla K., Kucharska-Jastrzębek A., Łandwajt M. . Hybrydowe Systemy Obrony z Zaawansowanymi Ceramikami i Włóknami Polietylen o Wysokim Ciężarze Molekularnym (UHMWPE). FIBRES & TEXTILES in Eastern Europe 2016; 24, 3(117): 79-89. DOI: 10.5604/12303666.1196616
The research was funded by the National Centre for Research and Development, Research Grant No. O ROB 0001 03 001



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Development of the procedure of the body-fitting ballistic protections using 3D-body-scanners affecting the ergonomics of the final protections

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Narodowe Centrum
Badań i Rozwoju

Developmental
project No. DOBR-
BIO4/045/13067/2013

„Individualization of
the design of the
multifunctional
vests”





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Evidence of success



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The development of the novel, advanced textiles materials, composites and related technologies (composite processing & 3-D scanning) will be affect the ergonomic (by reduction in mass and body-fitting) and safety of the final protections as well as improvement in their ballistic resistance.

The ideas of the realized researches are focused on the reduction of the mass of the ballistic protectors (1) with synergistic dissipation of energy and body protected areas (2) and better fitting of the personal, ballistic protections (3).

The reduction of the mass of the protectors (1) is able to achieving by utilizing the designing the hybrid fibrous composites supported by the screening of the ballistic textiles and modification of their surface properties by plasma treatment.

Reduction of BABT (behind armour blunt trauma) risk effect is originated from the effective modelling and body-fitting (using the 3D scanning; (3)) of the ballistic protections with application of the energy absorbers (2) (containing for example: STF-containing elastomers with or without nano- and/or micro-additives).



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Evidence of success



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The implementation of this GP to the practice in other regions of EU allows to significantly increase the safety of the practitioners acting in the defence and security areas by the reduction of the number of lethal cases or serious injuries. It will change the technologies of the personal protections by the implementation of the advanced, functionalized textile materials and composites with validated, high protection efficiency, thus improving the users' comfort and the ergonomics.

The proposed GP has significantly high aspect of the dual use technology being easy to modify or/adopt in several industry branches.

The success factor of the presented GP is mostly connected with the implementation to the practice in the manufactures with experience of the personal protections distribution in areas of the defence and security. The degree of the success will be improved by the implementation of the GP in place with the easy-to-adopt technical and industrial infrastructure.

The GP idea is easily adaptable to other products and industrial branches, where the demand increases every year. Due to the easy adoption, the proposed GP shows high flexibility and adoptability taking into the account leverage effect to trigger further improvements in policies and know-how.



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Difficulties encountered/ lessons learned



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The presented GP considers very specific market area: personal protections applicable in defence and security area, requiring the market knowledge, suitable technical and industrial infrastructure and human resources for the quality testing, manufacture realisation and logistic activities.

Following areas of the barriers that may effects or determine the extent of the excepted impacts were estimated:

- **structural and legal barriers corresponding mainly to the possible changes in the personal data protection and possible changes in the competitive tendering or pre-commercial tendering;**
- **economic barriers corresponding to the relatively quick market saturation with equal technologies or personalized/customized product;**
- **societal/ethical barriers corresponding to the anxiety for personal data sharing.**



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Potential for learning or transfer

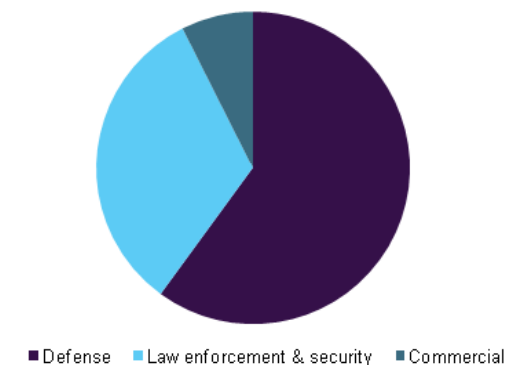
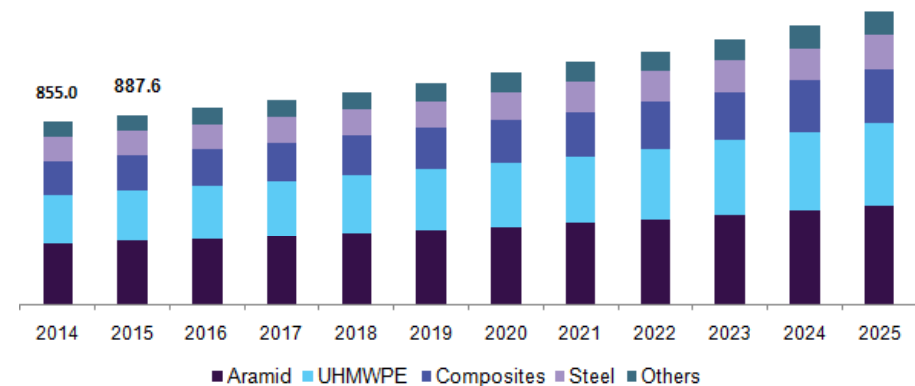


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Body-fitted ballistic personal protections are considered as a new generation of textile products applicable in protections actively providing support in fields of safety or health.

They are high-tech and highly specialized products with a high added value, due to implementation wide range of the innovation:

- functionalization of the textiles,
- hybrid composite technology and
- body-fitting.



Ballistic Protective Equipment Market Analysis By Material (Aramid, Composites, UHMWPE, Steel), By Product (Head Protection, Soft Armor, Hard Armor), By End-use (Defense, Commercial, Law Enforcement & Safety), And Segment Forecasts, 2014 - 2025

<http://www.grandviewresearch.com/industry-analysis/ballistic-protective-equipment-market> [2017-08-01]



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Thank you!



Project smedia

