STANDARDISATION OF SMART TEXTILES

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Sekcijsko predavanje

The concept of smart (intelligent) textiles describes a new segment of special textiles, which react or adapt to the changes in the environment as a result of integrated active functional materials, smart materials or active systems. Equal methods for the designation of smart textiles, reliable standardized testing and certifying methods are needed for quality production and successful market breakthrough. In the year 2007/08 CEN/TC 248 started to prepare the first general Technical report in this area. Cosmetotextiles are already arranged by a new Technical report TP FprCEN/TR 15917:2009*. Intense standardisation of smart textiles and clothing in the field of personal protective equipment also goes on. In this paper a global approach to the standardisation of smart textiles is presented.*

Key words: *smart textiles, standardisation, CEN/TC 248, cosmetotextiles*

INTRODUCTION

Interdisciplinary cooperation of textile technology with microelectronics, computing, pharmaceutical, chemical and other technologies led to the development of new technologically highly developed Smart Textiles and Clothes that are based on advanced, smart materials. These materials either feel the stimuli of the environment (passive smart materials) or they react to the stimuli of the environment by adapting their characteristics (active smart materials). They have functions of sensors, actuators or change their macro- and microstructure as a reaction to the environment (1).

Stimuli that activate smart materials within textile substrates are most frequently optical (visible light, UV rays, IR rays), thermic (body warmth, warmth of the environment, Joule warming), mechanical (deformation, pressure, tensile force), electric and chemical (water, sweat).

Responses to stimuli are different: changes of shape (shape memory polymers and alloys), dimensions (auxetic materials, shape memory materials), colours (smart dyes: photocromic, thermocromic, electrocromic pigments), structures (water vapour permeable membranes like DiAPLEX® or c_change™ membrane) or electroconductance (soft switches).

Scientists considered the year 2000 as a pivotal year for the development of smart textiles and smart clothing, which were for the first time introduced to the market in larger amounts. One of the first market products in the United States was smart shirt Sensatex for monitoring vital human functions (2). The development of smart textiles and clothing is most intensive in the USA, Japan and Europe, with increasing progress in the Southeast Asia (the South Korea, Taiwan and China).

The EU has funded a series of projects dealing with the development of smart textiles through the Framework programmes FP 6 and FP 7 (3). Many of these research results have already been patented. The business with smart fabrics and clothes is spreading in Europe and the USA where many traditional textile technology companies have closed over the last two decades. Textile researches have reoriented to the development of high value added smart fabrics and clothes.

Major application segments of smart textiles and smart clothing are consumer products, military applications, computing, biomedical, vehicle safety and comfort, public safety/homeland defence, and others (including logistics & supply chain management, signage and automotive interiors markets).

The U.S. market for smart textiles was estimated to 55.9 million € in 2006. It is expected that it will reach 309 million € in 2012, at an annual growth rate of 37.9% between 2007 and 2012. The sales of conductive fabric products are expected to more than double each year between 2007 and 2012 (4).

The global economic slowdown in 2010 put a damper on the apparel, shoes and accessories sectors. The high-end luxury sector suffered in particular, especially in the U.S. and Europe, where most of the smart textile consumer products launched so far into the luxury end of the performance clothing market (5).

GENERAL NEEDS FOR STANDARDISATION OF SMART TEXTILES

Because of quick fashion changes that stimulate the increasing needs for customisation and personalisation of clothes, import of enormous quantity of cheap clothes from China, lots of steps from the raw material to the product in the shops, a high degree of dispersion among many producing actors because of widespread use of subcontracting companies, the textile materials and clothes market has become extremely complex and requires the establishment of standards (6).

Standards allow suppliers, manufacturers and retailers to connect their businesses within the value chain. They facilitate trade, transparency and help to remove trade barriers. Standards help new products to be accepted by the market and increase confidence in the quality of products. Producers, merchants and consumers have become more and more conscious about the urgency of standardisation in the new area of smart textiles and clothes.

The needs for the standardisation of smart texiles and smart clothes increase with growing market. The development and use of smart textiles and clothes have opened many questions for producers and consumers related to:

- suitability of new terms,
- understanding of known terms in the new environment (as an example, many debates in the past were about a dilemma of using a term intelligent in connection with materials),
- suitability of existing test procedures and ability of evaluation of smart materials,
- needs for the development of new measuring devices and specifications and classifications of new products for the needs of the market.

Standardisation of new smart products is based on recognition of relevant properties to be standardised (what to measure), development of suitable methods to measure these properties (how to measure), introduction of criteria for pass/fail or classification (how to use the test results) and designation of important information that a user/consumer should know.

The quality of smart textiles and smart clothes in the market has to be considered from the viewpoint of the existing legal demands included in the EU Directives and national legislation together with supporting standards. Introduction of new risks, in particular with regard to vulnerable consumer groups, e.g. children, handicapped and eldery people, is not allowed. The development of suitable testing and assessment methods to ensure functionality and durability (influence of ageing and cleaning) of new products is an important need of producers and consumers.

New standards for Smart Textiles and Smart Clothes must be harmonised with the existing EU directives: General product safety directive 2001/95/EC, Construction products directive 89/106/EC, Directive on Personal Protective Equipment 89/686/EEC, Medical device directive 93/42/EC, Machinery Directive 2006/42/EC, Directive on the restriction of the use of certain hazardous substances in electrical and electronic equipment 2002/95/EC, Waste electrical and electronic equipment 2003/108/EC and Electromagnetic Compatibility Directive 2004/108/EC.

GLOBAL STATE OF STANDARDISATION OF SMART TEXTILES AND CLOTHES

Within the European Standardisation CEN two Technical Committees are responsible for publishing textile standards: CEN/TC 162 Protective clothing including hand and arm protection and lifejackets and CEN/TC 248 Textile and textile products. Standards inside TC 248 concern about test methods, terms and definitions, specifications and classifications, and equipment relevant for the testing and use of textiles. About 80% of all EN standards inside CEN/TC 248 were adopted simultaneously by CEN and ISO under Vienna Agreement in 2001 (7).

In 1994 CEN/TC 248 established a working group WG 9 »Prioritization of research topics«. In 1999 the WG9 redefined its scope into »Research needs in support of ongoing and future standardisation«. Since 2003 CEN/TC 248/WG 9 has been placing more emphasis on standardisation activities in the area of high added value textile products, including health care, well being, multifunctional textiles, interactive textiles, sustainable development, etc. Before 2004 there were no relevant national standards in the EU which descibed test methods in the area of smart textile and clothing. In 2004 CEN/TC 248/WG 9 decided to establish a group »Cosmeto-Textiles« to study the methods for the effectiveness, toxicity, durability and chemical analysis of textiles with cosmetic properties. In 2006 a new working group WG 25 was established to develop a technical report of Cosmeto-textiles. Technical Report (TR) is a document that provides information on the technical content of standardization work. The result of working group WG 25 is a standard Cosmetotextiles that was published in 2009 (8).

In the year 2006 European producers, which confronted problems of lack of standards of smart textiles very early, organised on the initiative of a Belgian laboratory of CENTEXBEL the first meeting on the topic of smart textiles in the frame of CEN/TC 248.

In the next year, i.e. in 2007, a working group WG 31 Smart textiles was founded in Sofia with a task to draft a Technical Report as a starting point for future standardisation of Smart Textiles until the end of 2008.

In the frame of CEN/TC 248 the studies on conductive properties of e-textiles started in 2006. So far no standard testing methods and specified requirements for e-textiles have been developed. Traditional test methods with special amendments are required for determination of the characteristics of e-textiles. Standards and requirements should be developed in a way that covers the multidisciplinary characteristics of e-textiles as textiles, as electronics and as computers (9, 10). Until now only Japanese fire-fighting uniforms on the market are certificated by the IEC standards (11)

Thermoregulatory properties of textiles that are determined by EN 31092 (12) and EN 15831 (13) standards are quite complicated and mainly related to protective clothing. In 2006 a special working group inside CEN/TC 248 started to work on better standardisation of thermoregulation of smart textiles and clothing. Original method and instrument simulating the real thermal conditions of the use of garments with phase change materials (PCM) is under consideration of CEN/TC 248/WG 28 Thermoregulation (14).

TECHNICAL REPORT »TEXTILES AND TEXTILE PRODUCTS - SMART TEXTILES - DEFINITIONS, STATE OF DEVELOPMENT, APPLICATIONS AND STANDARDISATION NEEDS« (WORKING DOCUMENT) (15)

In the working document (15) the term smart textile is determined as textile or textile product that possess additional intrinsic functional properties not normally associated with traditional textiles. A smart textile is determined as an active classic textile with built-in active function materials, smart materials or active systems. Active functional textile materials defined in the technical report are electrical, thermal and optical conductive materials, emissive, fluorescent and phosphorescent materials and materials releasing substances. Intelligent (smart) materials are chromic materials, Phase Change Materials, Shape Memory Polymers and Shape Memory Alloys, superabsorbing polymers and gels, auxetic materials, dilating and shear-thickening materials, piezoelectric materials), electroluminiscent materials, thermo-electric materials, photovoltaic materials), electrolytic materials and capacitive materials. Smart textile systems (e-textiles or electronic textiles or textronics) are composed of actuators, completed by possible sensor(s) and information management devices (processors) and are embedded/integrated into textiles by using various techniques. They can be characterised by an energy function (E) or without it (NoE) and by an external communication function (Com) or without it (NoCom) as:

- NoE-NoCom (e.g. garments equipped with shape memory material, or with phase change material, or with LED)
- NoE-Com (e.g. smart textile systems equipped with an electrical battery connected to a photovoltaic device)
- E-NoCom (e.g. heated gloves)
- E-Com (e.g. chemical sensor).

TECHNICAL REPORT TEXTILES - COSMETOTEXTILES (8)

Cosmetotextile is a textile consumer article containing a durable cosmetic product, which is released over time. Cosmetic products with moisturising, slimming, perfume, energizing, refreshing, relaxing, vitalisating, UV protection and other effects may be contained in a microcapsule, cyclodextrin or embedded in any other suitable way. Colour fastness of cosmetotextiles to water, rubbing, perspiration, domestic and commercial washing, and dry cleaning should be controlled under EN ISO 105 standards. The quality of cosmetic products should be in accordance with EN ISO 22716 standard describing the cosmetics good manufacturing practices (16).

In future textile standars connected with cosmetotextiles there will be considered:

- the way of fixing cosmetic products and additives on a textile substrate,
- toxicity of textile finishing (acute toxicity, skin and eye irritation, skin sensitisation, dermal absorption, dose toxicity and genotoxicity),
- efficiency of cosmetotextiles where special methods will be developed,
- durability (presence of cosmetic product after washing, influence of rubbing, sweat and heat on cosmetic products), and
- labelling of the cosmetotextiles with information about textile composition, care conditions, tracebility number and identification of the cosmetic product.

Environmental aspects are considered to be less critical than the above listed criteria.

CONCLUSIONS

Smart textiles have been expanded to different areas of textile materials usages: in clothing (medical applications – monitoring and treatment, protective clothing – thermal insulation, barrier properties, visibility, military equipment, security – access control, identification, localisation of persons), in technical textiles (leak detection in geotextiles, self-repairing textiles, non-staining surfaces, ..) and in home textiles (carpets, upholstery, beds) to increase security (access control monitoring) and comfort (adaptation to morphology) (17). Standardisation of this fast developing textile area is at the beginning. Until September 2010 there wasn't any EN or ISO standard for smart textiles.

Development of new standards will follow development of the area of smart textiles both in terms of new terminology as well as with the development of new methods and application of the existing standards in the area of textiles (CEN/TC 248) and other areas of EN standards (CEN, CENELEC - electro-technical and ETSI - telecomunication domain) and international standards (ISO, IEC- electro-technical, ITU- telecomunication).

The technical report (15), which is under preparation, will provide the solution of basic terminological problems related to the proper use of new terms and definitions of smart materials, and will define the elements to be standardised and propose the concepts of a systematic approach to the standardisation of active smart systems.

Standardisation is a condition for sustainable development of smart textiles in the future.

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