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FACULTY OF ENGINEERING

Projects related to smart textiles at Ghent University

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1. TIS: THEMATICAL INNOVATION STIMULATION - APPLICATION OF SMART TEXTILES IN CLOTHING

This project aims at promoting networking between all parties involved in the "clothing" value chain, the specialized knowledge centres and the technology providers in the framework of using smart textiles in clothing.
Nowadays, Western (Flemish) companies can only continue when they keep specialising in products with a high added value.
The application of smart textiles in clothing provides on the one hand an answer to realistic needs relating to health, protection, communication, comfort and safety of various users. On the other hand, this application creates new and economically interesting opportunities for the innovative textile entrepreneur. Moreover, smart clothes aim at a whole range of users, such as sportsmen, intervention teams, older people and disabled people.
The field of smart textiles has practically unlimited possibilities and what is more, it is to a large extent virgin territory. The time has come to instigate Flemish companies in the "clothing" value chain to take this innovative course.
Through a dynamic networking between the players involved, the real possibilities with regard to the application and the maintenance of smart textiles will be made public, demonstrable and negotiable. This action aims at encouraging Flemish companies to start company specific innovation projects, whether or not in co-operation with specialised technology providers and/or knowledge centres.
This **IWT**-supported project is carried out in co-operation with Centexbel and IMEC.
(1/09/04 – 31/08/06)

2. SMART TEXTILES FOR CHILDREN IN A HOSPITAL ENVIRONMENT (STWW-PROGRAMME (STRATEGIC TECHNOLOGIES FOR WELFARE AND PROSPERITY))

The field of smart textiles is continuously gaining interest. Worldwide research is performed contributing to the realisation of biomedical clothing. The development of new textile compatible materials and interdisciplinary teamwork makes this evolution possible. Our department has established a consortium with Ghent University Hospital, the Paediatric department and the department ESAT-MICAS (Micro-electronics and sensors) of KULeuven. Several Flemish companies (textile and others) are member of a user committee. They provide material and share their knowledge and experience.

Within the project an analysis is made of what is meant by smart textiles, what components are required to develop a smart textile suit, what materials can be used and what are their requirements.
In addition, research is focused on the development of a stand-alone monitoring suit for babies. The emphasis is put on the sensing capacity of the textile material. Two textile biosensors and their related electrical circuit are produced: one for the measurement of heart rate and ECG (Textrodes) and one for monitoring the respiration rate (Respibelt). Apart from that, an inductive power link and interconnections in textile material and integratable electrical circuits are developed. The project finished in 2004 and a prototype baby suit has been delivered and used for clinical testing. The little mice are the textile sensors. Their tails connect them to the flexible electrical circuit. The textile coil on the baby suit is the reception coil of the inductive power link and the bi-directional data communication link. The double function of the link avoids the need for batteries on the one hand and provides a wireless communication tool with the baby suit on the other hand. The second coil can be integrated into the mattress.
This Flemish STWW-project is carried out from September 2000 till August 2004 and is financed by **IWT**.

3. DATA TRANSMISSION AND WIRELESS COMMUNICATION FOR SMART TEXTILES (FWO)

Garments, being our second skin, are the ideal carrier for supporting functionalities such as sensors for monitoring health or environmental changes. This leads to the creation of wearable textile systems, typically composed of the following components: sensors, actuators, signal processing circuitry, power supply units and data transmission systems. Much attention is being paid to research in this emerging field.
This project focuses only on the part of data transmission, meaning communication within the garment and between the garment and the environment to realize a stand-alone suit. It is clear that most of the advantages of smart textile systems are lost when wireless data transfer is not available. This requires the development of suitable antennas.
Electroconductive yarns and flexible electrotextiles have become available in recent years. In the framework of this project, the properties of these materials will be exploited to realize antennas entirely built out of textile material and integrated into garments. In order to design these textile antennas, the behaviour of conventional textile materials in the frequency range of the ISM-band [2.4 - 2.485 GHz] will have to be determined.
The aim of this project is to perform the basic research that is needed to realize electrical interconnections for data transmission and antennas for wireless communications in intelligent textile systems.
The results of this fundamental research project are an ideal starting point for more industrially oriented applied research projects in this field.
To conduct this research, the expertise of two research groups of Ghent University is combined: the Electromagnetics Group of the Information Technology Department (INTEC), together with the Department of Textiles.
(1/01/05 – 31/12/08)

4. SEMI-CONDUCTING TEXTILE FIBRES AND THEIR APPLICATION IN FLEXIBLE PELTIER ELEMENTS (FWO AND IWT RESEARCH PROJECTS)

Peltier elements are currently very successful given the possibility to use them as a cooling or heating system when applying an electrical current. Depending on the current direction, cooling or heating is obtained; when inverting the current direction, the cooling and heating effect will be inverted as well. This means that heating and cooling can be obtained at the same plane of the element by inverting the current which is sent through that element.
However, Peltier elements have a rigid structure, which reduces their application possibilities. For that reason, the idea was put forward to develop flexible Peltier elements on the basis of textile structures. This means that fibres have to be available possessing the appropriate semi-conductor properties (such as Bi-Te) for an optimal Peltier effect. Alternative semi-conductor fibre structures have already been described, but they are less suitable for application in Peltier elements.
The aim in this research project is to take a first step in that direction by conducting fundamental research into the electrochemical deposition of Bi-Te layers on different electrode materials and under varying circumstances and to study the properties of these layers with electrochemical and surface techniques. Gaining insight in the deposition and the properties of the deposited layer in view of the production of suitable semi-conductor properties is a second aim in this project.
(1/08/05 – 28/02/06)

5. CLEVERTEX - DEVELOPMENT OF A STRATEGIC MASTER PLAN FOR THE TRANSFORMATION OF THE TRADITIONAL TEXTILE AND CLOTHING SECTOR INTO A KNOWLEDGE DRIVEN INDUSTRIAL SECTOR BY 2015 (SSA 517006)

The European project CLEVERTEX was finalized in March 2008 after a runtime of 2,5 years. The project aimed at defining a plan and setting directions for future actions in research, education and technology transfer in the field of smart textile materials in order to transform the European textile and clothing industry into a knowledge-driven and sustainable sector by 2015.
To achieve this challenging goal, the work programme foresaw different actions that were closely correlated to and were built on top of each other resulting in a roadmap for smart textiles. The different building stones included an analysis of the available European knowledge base for smart textiles and an investigation of the socio-economic framework of the textile and clothing sector, as well as foresight studies, including a Delphi study to identify needs and barriers for the scientific and technological development of smart textiles, a Gap analysis and a feasibility study.
The different elements as well as the final roadmap were presented during the *Interactive Textile Days* in Portugal in March 2008. Furthermore, the roadmap will be available as an issue of the journal Textile Progress in early 2009.
(1/10/05 – 31/03/08)

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6. PROTECTION E-TEXTILES: MICRONANOSTRUCTURED FIBRE SYSTEMS FOR EMERGENCY-DISASTER WEAR (IST-4-026987)

The Integrated Project Pro-e-TEX concentrates on the development of *e-textiles* to be used in wearable textile systems for emergency disaster intervention personnel and injured civilians. The international consortium joining forces in this project consists of 23 partners from 8 different countries resulting in a representation of the most important European textile regions i.e. Italy, France, Poland and Belgium.
The aim of the project is to develop textile-based systems which increase the safety and efficiency of personnel intervening at disasters such as fires, earthquakes, floods and terrorist attacks. Unfortunately real world incidents have attracted our attention to the necessity to build infallible communication and protection systems. The emergency services which arrive at the disaster site in the first hours need to receive maximum protection. In the last decades the quality of the emergency disaster wear has improved considerably due to the application of e.g. high performance fibres. ProeTex, however, wants to bring emergency disaster wear to a higher level of protection by considerably increasing functionality. To do so, protective clothing should be considered from a more systemic point of view with components such as sensors, actuators, signal processing unit, energy supplies and communication systems integrated in the suit. This leads to a multifunctional suit which offers the following features:

- ·continuous monitoring of body signals e.g. respiration and heart rate;
- ·activity monitoring;
- ·internal and external temperature monitoring;
- ·chemical detection;
- ·wireless communication between the garment to a base station;
- ·energy supply.

Not all of these functions can be realised in one garment. For monitoring the vital signals, close contact with the skin is required, while other sensors need to collect data from the wearer's environment. For this reason the suit consists of 2 parts: an inner and an outer garment. Also the shoes are part of the system. For the victims a patch is developed which can closely monitor the wearer's health condition. A wearable communication system is provided to transfer the collected data.
The technological developments necessary to realise this garment emphasize on the development of e-textiles in the shape of fibres, although conventional microsystems will also be considered to reach the anticipated goal.
The project is structured to produce 3 incremental sets of prototypes in the course of its programme. In 2007 the project proceeded to completion of the first set of prototypes. The prototypes underwent a rigorous series of tests, from laboratory tests of the performance of individual sensors and components, to evaluations of the performance and usability in the field. This information was used as a basis for developing the second generation of ProeTex prototypes in 2008.
This project combines the expertise of several important European research groups involved in intelligent textiles. Also, a considerable number of companies is involved. The developed prototype garments are tested by the end users contributing to the project (the Italian and French Civil Protection and the Paris Fire Brigade).
Ghent University contributes to several aspects of the project. Yarns and fabrics are coated with precious metals such as gold in order to improve the quality of the textile electrodes to be integrated into the inner garment. The communication between the outer garment and the

environment is established by a textile antenna. Finally, the Department of Textiles is responsible for the training programme and the workshops, both internal and external, organised within the scope of the project. In 2008, a **workshop** on *'Energy generation and storage through textiles'* was organised in Portugal. In September 2009, a **Smart Textiles Salon** will be organised in Ghent, showing the latest prototypes.
More information at www.proetex.org.
(1/02/06 – 31/01/10)

7. LIDWINE MULTIFUNCTIONAL MEDICAL TEXTILES FOR WOUND PREVENTION AND IMPROVED WOUND HEALING (41F05606)

The European project Lidwine specialises in developing multifunctional medical textiles for decubitus (bed sore) wound prevention and improved wound healing. With 19 partners from nine European countries as well as Israel, the Lidwine consortium constitutes a multidisciplinary team covering the full textile supply chain as well as sectors like medicine, material science and electronics. The project started in September 2006 with a runtime of 4 years.
The challenge of this project is to establish systems that prevent wounds from occurring at decubitus-risked skin areas and in addition to create optimum wound healing circumstances. In order to achieve this goal different pathways will be followed. Thus, textile systems including an antibacterial textile for wound care with integrated medication depots that release the medication in a controlled way and an active circulation support bandage with reduced friction properties will be developed.
The Department of Textiles is actively involved in the development of the latter system and develops textile bandages with integrated electrodes for electrical stimulation together with Bota, a Belgian SME specialized in medical textiles, and Soliani, an Italian company having expertise in electro-conductive textiles. The aim is to develop textile-based or textile-compatible electrodes that offer a homogeneous current density profile to avoid burning injuries of the human skin. Different materials, including metal yarns, polypyrrole and gold coated fabrics have been investigated. In order to predict the current flow in electro-conductive textiles a simulation tool has been developed at the Department of Electronics and Information Systems (ELIS) of Ghent University.
(1/09/06 – 31/08/10)

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8. SYSTEX COORDINATION ACTION FOR ENHANCING THE BREAKTHROUGH OF INTELLIGENT TEXTILE SYSTEMS (E-TEXTILES AND WEARABLE MICROSYSTEMS) FP7-IST-SUPPORT ACTION 2007.3.6 MICRO/NANOSYSTEMS 224386

SysTex is a project funded by the European Commission and involves besides Ghent University eleven other European institutions and companies. The project is a coordination action for enhancing the breakthrough of e-textiles and wearable microsystems in Europe. SysTex started in May 2008 and has a duration of 36 months.
The project aims to be the driving wheel towards intelligent textile systems geared to the European lead markets: Medical, Transport, Protective and Sports & Wellness. Furthermore, it focuses on developing a framework for current and future actions in research, technology transfer and education in the field of wearable microsystems and e-textiles in Europe. The textile industry shall be transformed in the most efficient and effective way into a dynamic, knowledge-driven, innovative, competitive and sustainable sector.
Besides coordinating the project, the Department of Textiles is mainly involved in work package 2. In this work package, the aim is to construct a SysTex database collecting information about intelligent textiles and to make this data available to the public. The work in WP2 is aimed at facilitating and speeding up the process of searching for information which will enhance research work in the area of intelligent textiles.
The objective of SysTex is to identify the drawbacks in the interdisciplinary knowledge transfer and to initiate actions to overcome them. SysTex has a strong market-driven focus and is geared to foster cooperation between the different knowledge carriers: industry, academic, government institutions, research and development and users of the technology.
More information on www.systex.org
(1/05/08 – 30/04/11)

9. EL2VINT ELASTIC, ELECTRICALLY CONDUCTIVE TEXTILE STRUCTURES FOR INTELLIGENT TEXTILES

The TETRA (TEchnology TRAnsfer funded by IWT) project ‘el2vint’ (which stands for ‘elastic, electrically conductive textile structures for intelligent textiles’) started in October 2007 and lasts for two years. It is a joint project between the textile departments of both Ghent University and University College Ghent. Additionally, a selection of Flemish companies contribute to the project. The project results from a need for conductive elastic yarns to be applied into intelligent textile systems. These systems commonly rely on electrical properties and can benefit from elastic properties when integrated into a garment, e.g. a heart rate sensor can be brought in close contact to the skin when integrated into a stretchable undershirt.
Conductive yarns can be produced in various ways and obtain very different properties in terms of conductivity or touch. This project focuses on manufacturing yarns and textile structures and

characterize them in terms of mechanical and electrical properties, processability, durability. The yarns are developed applying the hollow spindle spinning process, where an elastic core yarn is combined with an electrically conductive yarn. In the first project year, a variety of yarns based on stainless steel and on copper has been produced and tested. The textile structures are manufactured in collaboration with Flemish textile companies.
During the second project year, upscaling guidelines for the manufacturing of the yarn will be formulated. Furthermore, three prototypes in which the electrically conductive elastic yarns are applied, will be worked out.
For more information, please visit www.el2vint.be
(1/10/07 – 30/09/09)

10. SMART SCHOOL (WETENSCHAP MAAKT KNAP, TEXTIEL MAAKT SLIM) (WI/2006/066)

In this project students of primary and secondary school become acquainted with intelligent textiles. The schools which are involved in this project are all part of *Pantarhei* (school group 22 of the public school system). The idea is to have one large project around intelligent textiles. The different schools can work out different aspects, which will be brought together later on. Because intelligent textiles is a very broad subject, it can be used in different disciplines in the public school system. Examples are physics, chemistry, biology, but also English (student can summarize English texts about intelligent textiles), economy (students can make a cost-benefit analysis), etc.
The project consists of 4 types of subprojects, which are partly connected to each other:

- The development of material by the students themselves as a part of their learning process
- Students demonstrate their realizations or pass on their acquired knowledge to other students, as a part of the education programme
- The development of research competences
- Distribution of the results

There are four central themes forming the subjects of all 4 subprojects:
· Self-heating sweater
· Textile antenna
· Are you still breathing?
· Measure your heartbeat
The task of the Department of Textiles is to give scientific, technical and educational assistance to the teachers and/or students of the different schools. The Department also has some materials at its disposal, which can be used by the different schools for e.g. demonstrations. Besides Ghent University and *Pantarhei*, also *Fedustria* is involved in the project. They deliver materials, organize visits to companies and sponsor different activities.
At the end of the project, there will be a grand finale at which other schools can also be introduced to the project.
(15/12/06 – 14/12/09)

11. NO BUG - NOVEL RELEASE SYSTEM AND BIO-BASED UTILITIES FOR INSECT REPELLENT TEXTILES AND GARMENTS

In several applications of professional textiles and clothes mosquito repellency is an important issue. Two major problems arise:

- repellents currently in use are harmful, resistance to conventional repellents increases,
- the lifetime of release systems is too short.

Solving these two problems are the main goals of the No Bug project. Novel biorepellents will be considered and evaluated as well as two release systems (multilayer coating and textile bioaggregates) in order to repel mosquitoes causing malaria or dengue. Novel release concepts are multilayer coatings and in situ release of the active compounds. Targeted prototypes are textiles for health workers and bed nets (mosquitoes). The project will study what are the best conditions of use of the biorepellents and how to integrate them in the textile products. Testing, exploitation and dissemination will be an active part of the work.

12. TEXTIELMOBIEL

(1/01/09 – 31/12/11)