STELLA Newsletter I

STretchable ELectronics for Large Area applications

Welcome to the first issue of the STELLA Newspaper.
STELLA is a EC funded project within FP6 (IST-028026), see: www.cordis.lu. In this project a new technology platform will be developed as a consequence of the ambient intelligent vision where the citizen carries along more and more electronic systems near the body, on or even inside the body.
This newsletter has the ambitious aim to support the dialog between the Stella Consortium and the development communities, which work on similar topics respectively potential customers.
We want to inform you in the first issue about all general subjects of the project, the objectives, the possible applications, the background and the partners.
The following issues will keep you in track about the progress of the project, new applications, market news, information and activities from neighbouring projects in the same research area.

Content Issue No. 1:

I The STELLA Project

II Applications and Market

III The Partners

I The STELLA Project

Why stretchable electronics?

It is believed that in the near future more and more electronic systems will be carried by the citizen near the body, or as a part of his body in order to provide various services to him.

Wearable electronics should not hamper the comfort of the user and ideally it should be almost non-noticeable to him.
The consequence of this ambient intelligent vision is the need of light weighted electronic systems which preferably take the shape of the object in which they integrated, and must even follow all complex movements of the object.
Typical examples are intelligent textiles, personal healthcare, fitness monitoring,

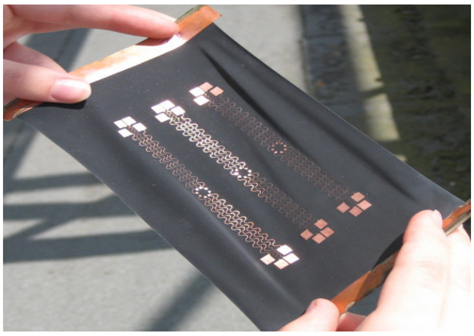

Fig.1 Stretchable substrate

skin-like electronics in robotic applications, car electronics etc. The electronic systems for these applications have to be bendable and even stretchable with soft-touch nature. … → page 2

The aim of Stella is to develop a new technology platform for stretchable electronics.

In view of the EC-Comission: The integrated IST-project STELLA

Written by Thomas J. Sommer, Project Officer, European Commission, Directorate-General Information Society and Media Unit Micro- and Nanosystems

STELLA was a pertinent response to the relevant Strategic Objective of the IST Call 4 of the 6th EU Framework Programme for Research and Development, addressing among others integration of large area flexible and stretchable electronics. The project objectives represent a clear progress if not a leapfrog beyond the state-of-the-art worldwide.

Although STELLA with its objectives is *per se* highly innovative, the importance and impact expectations of STELLA have to be seen in the context of clustering with other projects. Only the collaboration and exchange of information with projects will provide the synergies necessary for a breakthrough on a European and worldwide level and achieving a real economic impact for the European industry. … → page 3

STELLA was a pertinent res-ponse to the strategic objective of the IST Call 4 of the FP6.

Information Society Technologies
RESEARCH

www.stella-project.eu

I The STELLA Project

Why stretchable electronics?

Ctd. from page 1. That means even flexible substrates are no longer useful and will be replaced by stretchable alternatives.
Mechanically stretchable electronics are non-existing in the market.

Today this technology is an embryonic research domain with however a vast number of potential applications.

In the STELLA project the development of such stretchable and soft-touch substrates, including electronic assembly on these substrates is proposed.

Mechanically stretchable electronics are non-existing in the market.

Project summary

The technological basis of Ambient Electronics is a network of almost invisible, networked computing nodes; information is collected using various sensors, which is then processed and the environment altered accordingly.

Physically Ambient Electronics consists of three technology elements:

- Non obtrusive sensors that measure relevant (body) parameters and which are small, low weight and preferably wireless
- Algorithms that interpret these measurements
- Connectivity, preferably wireless to transfer the data to a body network for further processing

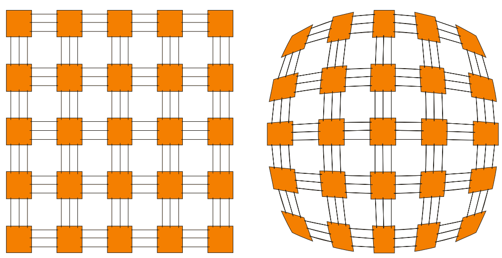

Fig.2 Requirement for more than one-directional stretchability of a distributed electonic components network

The aim of Stella is to develop a technology platform of enabling interconnection and packaging technologies for these challenging electronic systems.

Therefore STELLA shall develop at least the following innovative technologies for large area applications:

- A new stretch- and bendable substrate with stretchable conductors
- Assembling technology adapted for stretchable substrates
- Integration methods for stretchable electronics in elastomeric parts
- Manufacturing methods for stretchable electronic systems

The main objective of this project is the development of stretchable electronics for large area application for use in health care, wellness and functional clothes, and for integrated electronics in stretchable parts and products. Stretchable electronics includes the integration of electronic components, energy supply, sensors, actuators or display and switches on a stretchable substrate with stretchable conductors.

In order to achieve the final goal of a versatile packaging technology with stretchable substrates the following build up of activities is foreseen in the project:

The STELLA consortium will use existing stretchable materials (elastomers and non woven) and - if needed - will also develop new materials to manufacture stretchable base materials. On the new base materials, stretchable conductors are deposited. An important task will be to develop new methodologies for qualifying and testing electronic systems on stretchable substrates. The concepts of the stretchable systems must be applicable on large areas. The envisaged range of stretching is 1-50%.

Another important issue will be the development of an assembly technology for electronic components (bare dies, packaged dies, sensors, connectors, passives…) onto the substrate. Existing assembling will be adapted for stretchable substrates and vice versa for an easy implementation of the new technology.
The technology developments will be supported by modeling activities (electrical, mechanical, thermal and thermo-mechanical). The stretchability of the materials in the modeling environment will require innovative approaches from the modeling. These supporting activities will be carried out throughout the project.
(… → page 3)

The project focuses on stretchable substrates, conductors and assembly technologies for large area application.

…also energy supply, sensors, displays and switches have to be integrated…

To develop new methodologies for qualifying and testing electronic systems on stretchable substrates will be an important task.

Existing assembling will be adapted for stretchable substrates.

The technology platform approach, allowing different technologies and materials to be used to achieve optimum performance for a specific application, will be eminent to fulfil the requirements in the different application areas. Throughout the technology platform development, the manufacturability and cost will be the leading themes, as these are essential for future exploitation of the technology and wide spread use in the consumer, professional and disposables market, which all demand low prices.

The technology platform for stretchable substrates and systems will be demonstrated during the second half of the project time span by designing and producing functional demonstrators in different application areas: wellness, healthcare, sports, automotive etc.. The demonstrator activities will be triggered by the end-users in the consortium from the very beginning of the project.

The proposed scientific and technological objectives are well beyond the current state-of-the-art worldwide. Successful developments in STELLA will open a vast number of applications due to the unique features of this technology. In Europe great potential of this technology is seen in the area of wearable electronics close to the human body and mechatronic parts with stretchable structures.

…the manufacturability and cost will be the leading themes…

…great potential of this technology is seen in the area of wearable electronics close to the human body and mechatronic solutions in the Automotive sector

In view of the EC-Comission: The integrated IST-project STELLA

Ctd. from page 1: Here, an active or potential collaboration with running FP6 projects SHIFT (addressing flexibility, bendability, hence substantial developments on flex technologies), FLEXIDIS (flexible displays, substrate handling procedures), POLYAPPLY, (application of polymer electronics, r2r manufacturing), ROLLED (printing of both active and passive devices by means of r2r manufacturing) and CONTACT (fabrication of organic electronic arrays) should be borne in mind.

These projects or their subsets have among others in common ***non-woven*** manufacturing technologies, i.e. they are sheet based together with some of the features, as mentioned above.

Furthermore, there exists a project cluster "Smart Fabrics, Interactive Textiles and flexible wearable systems" (SFIT), consisting of the following projects: MY HEART, MERMOTH, OFSETH, CONTEXT, BIOTEX, PROETEX, and STELLA. Although the latter cluster focuses on smart textiles, based on ***woven*** technologies using different types of yarns to act as sensors and electrodes, the objectives and problems for envisaged applications with direct skin contact and/or cost-effective manufacturing are similar to those in the former cluster.

The commonalities of those two clusters are features like flexibility, integration, large area electronics, use of cost-effective technologies, partially usage in harsh environment. STELLA is hence positioned on the cross-road between the projects belonging to one of the two clusters and as such constitutes an important link between them.

The STELLA project is expected to be a major contribution to become great success story in future intelligent large area electronics applications. STELLA will help to bring the vision of Ambient Intelligence closer towards reality.

Only the collaboration and exchange of information with projects within clusters will provide … a breakthrough and achieving a real economic impact for the European industry.

STELLA will help to bring the vision of Ambient Intelligence closer towards reality

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Disclaimer: The views expressed in the above article are solely the views of the author and do not necessarily represent the official opinion of the European Commission.

Within the STELLA project the following applications are targeted for the implementation of stretchable electronics:

- Fitness monitoring
- Wound healing
- Infant respiratory monitoring
- Smart passenger compartment surface
- Pressure sensing in smart shoes

Fitness monitoring

Until now all monitoring of body functions occurs through wired interconnect. Adidas has a shoe product with integrated sensor, measuring speed and distance and using energy scavenging from the step movement.

Philips is a technology, medical and wellness oriented company. Monitoring of essential body parameters during exercise is essential for keeping the body in shape

The big advantage over existing products with the planned developments in the STELLA project is the stretchability and bendability and soft touch effect of the electronics. Furthermore the wireless interconnect and miniaturization in electronics allows for unobtrusive and comfortable use.

Wound healing

Chronic wounds are a significant health problem around the world. The serious morbidity and economic effects of chronic wounds make them a global healthcare challenge. The ageing of the population and more adequate treatment of the wounds explain mainly that the market of prevention and of treatment of the wounds is increasing greatly.

Chronic wounds - including pressure ulcers, venous ulcers, and diabetic ulcers - are serious health concerns worldwide. Millions of people are affected each year, with the total cost of their care reaching billions of euros. Chronic wounds reduce quality of life and may lead to infections, pain, and even death. So prevention of chronic wounds should be the primary goal in the area of wound care.

Urgo, participant in the proposing STELLA consortium, offers health professionals and patients innovative and effective products for the prevention, the protection and the treatment of the skin and wounds.

The main objective for Urgo is to deliver information to the clinicians enabling them to carry out effective prevention or treatment of wounds. This development is of major interest to allow clinicians to react as fast as possible when adverse factors have been detected. Also, the home care tendency results in the emergence of new needs.

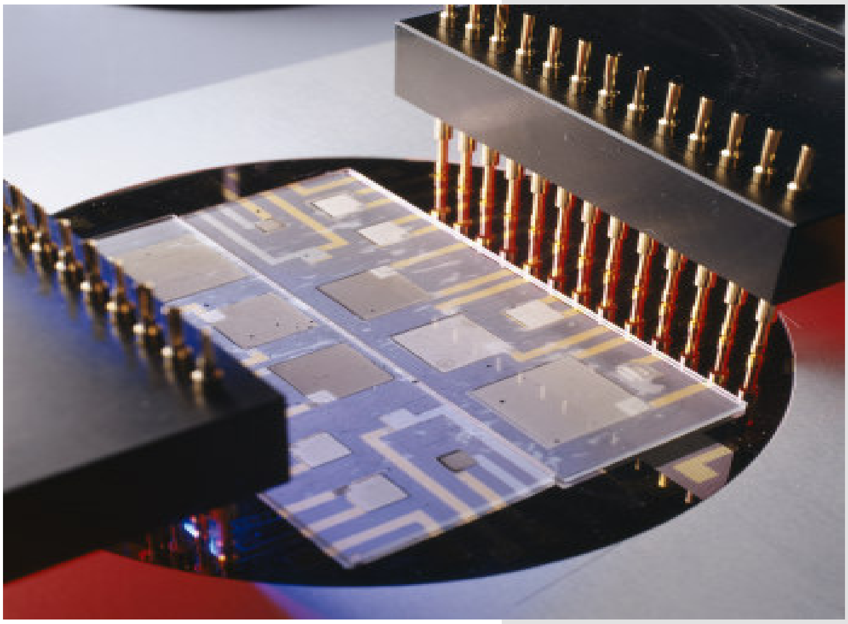

Fig.3 CEA: µbat-test

Infant respiratory monitoring

At the moment reliable baby monitors are only available on the high-end medical market for Sudden Infant Death Syndrome (SIDS) monitoring. Because social security regulations become stricter less parents will get appointed to use such a baby monitor. There is also a latent need of parents to guard the baby's health when they are asleep, while making no noise. Current baby phones do not offer this functionality. These aspects lead to the necessity of developing of a reliable, comfortable consumer product with an acceptable price.
Current state-of-the-art life science monitors make use of traditional analogue sensing technologies. These sensors are merely combined with, than truly integrated into them. We also notice that current state-of-the-art sensor technologies are merely found in high-end medical devices, hence operated by professionals and marketed at a very high end user price. Consumer products, however, require ergonomic solutions meeting different demands. Today, one of the major challenges to port these applications to the market is found in user convenience.

The activities of five demonstrators will be triggered by the end-users.

Today, the state-of-the-art sensor technology is not available to be manufactured on a large scale and hence offering an end user baby monitoring device. The substrate driven sensor technology developed in this project is recognized to become a key technology in wearable applications. It will enable manufacturers of such devices to develop and market systems that accurately measure different physiological parameters in a more comfortable and less expensive way. Users will not notice the presence of a sensor as it becomes fully integrated into the textile, but these stretchable sensors will also require additional features to resist washing and hence deterioration, etc.

On the other hand the current life science monitors have wired sensors and are battery operated. Using wires is a major problem especially for the baby market because of the risks of suffocation. The wireless functions on a stretchable substrate developed in the Stella project will improve safety, usability and pricing and hence improve acceptance of these products into the market.

Smart passenger compartment surfaces

The actual wiring in automotive passenger compartment is done either by round wires or by flexible flat cables. With the flex technology it possible to cover areas of surfaces. These areas can get functionality by the integration of switches, sensor elements, heating devices, etc. The disadvantage of the actual flexible flat wiring is the impossibility of covering a surface with a complex shape. This is illustrated by the following picture: a flexible substrate can be bended and folded but due to the lack of stretchability it is not possible to cover a complex shaped surface.

The complex structure of today's surface elements in automotive passenger compartment is realised by deep drawing. Thermal shapeable materials are used which provide a one-time stretchablility for the forming process. These elements do not contain electric circuits. The combination of stretchable materials and stretchable conductors lead to the possibility of manufacturing complex shaped elements with additional electric functions.

Pressure sensing in smart shoes

Flexible and stretchable electronic substrates for applications in shoe components are not known so far. A few patents and inventions, where electronics have been integrated into shoes have already been emerged:

- For instance in US_5914659_A1 an alarm device is described which gives a warning when children's shoes are too tight or too small.
- Adidas has just invented a shoe with self-adjusting damping.

In addition several patents on shoes with adjustable size have been found, e.g. US_20030106244_A1. None of the patents encountered so far has stretchable electronics integrated into a non-woven. Furthermore, a possible demonstrator could combine both foot size measurement and size adjustment.

Fig 4. Product sample

On one hand the demonstrators will serve for guiding the applicational development.

On the other hand customers shall be interested by the projects results by means of fully qualified technology-demonstrators.

III The Partners

The consortium of the STELLA Integrated Project on 'Stretchable electronics for large area applications' is set up as a 'lean' consortium. Participants have been selected based on proven background experience in one or more of the areas of research proposed.

The proposing STELLA project consortium is made up of ten European participants, coming from four different Member States of the European Union.

Below you will find a description of the major roles of each participant in the STELLA project.

Freudenberg

- Project coordinator
- Coordinator of the Workpackages (WP) 2 (Stretchable substrate technology) and 11 (STELLA management activities)
- Responsible for the development and supply of strechtable substrates.
- Responsible the demonstrators "Smart passenger compartment surfaces" and "Smart shoe insole".
- Third Parties:
  - Freudenberg Bausysteme KG
  - Freudenberg Vliesstoffe KG
  - Freudenberg NOK Mechatronics

IMEC

- Coordinator of the WP 4 (Modelling and characterisation) and 10 (STELLA training activities)
- Responsible for conductor structuring and patterning, and surface finishing/ termination (WP2); electrical and mechanical modelling (WP4); flex fabrication on carrier wafers (WP 1,2,4) flexible antenna development (WP6) reliability testing of test vehicles (WP7)

TU Berlin

- Coordinator of the WP 3 (Interconnection, assembly and embedding)
- Contributing to the test vehicles and reliability activities in WP 7
- Contributing to the training activities of STELLA

CEA

- Coordinator of the WP 5 (Power supply)
- Responsible for the integration of micro-batteries on stretchable substrates
- Hybridisation and power management of micro-batteries.

Philips

- Coordinator of the WP 1 (Specifications and enabling technologies) and 9 (STELLA demonstration activities)
- Responsible for the assembly technology on stretchable substrates using soldering technology
- Reliability assessment
- Fitness demonstrator

QPI

- Coordinator of the WP 7 (Technology integration)
- Responsible for evaluation-strategy and testing of system performance. Coordinates the issue catalogue.

BESI

- Participates in the development of stretchable conductors on flexible substrates (WP2)
- Participates in the manufacturability assessment (WP7)

Verhaert

- Responsible for the validation of the STELLA concept through the infant respiratory monitor demonstrator

Urgo

- Responsible for the validation of the STELLA concept through the woundcare monitor demonstrator

Fundico

- Responsible for definition of technical and formal workplan
- Assistance to Freudenberg for the coordination and management of the STELLA project.
- Responsible for the cost assessment of the developed stretchable electronic technologies and applications.

PITS

- Coordinator of WP 6 on 'System design'

Introduction of a further project of STELLA project partner IMEC:

BIO-Flex – BIOcompatible FLEXible electronic circuits

The objective of the proposed BioFlex project is to develop a technology platform for flexible and stretchable, high density, high functionality, reliable and biocompatible (implantable) electronics systems. To reach this ambitious goal the following logical build-up of activities is foreseen in the project:

A. Biocompatible materials development

A range of polymer materials basing on PU (Poly-Urethanes) will be synthesized with tailored physical properties which make them suitable for serving as base flexible and stretchable carrier for electronics circuits. Surface Technologies (e.g. chemical grafting) will be developed to chemically modify the surface of these materials, so that sufficient adhesion of interconnection metals can be achieved. This has to correlate with novel polymer coatings which can prevent or substantially reduce protein adsorption and incompatibility reactions. These developments will be verified by extensive biocompatibility testing procedures.

B. Flex substrate development

A number of biocompatible flex interconnection circuit technologies will be developed. The substrates shall be stretchable and can be reshaped after assembly for implantation. The Silicone (PDMS) circuits (first back-up): will be stretchable, but cannot be reshaped, "Standard" Polyimide circuits, covered with PDMS (second back-up): will be foldable/bendable, but not stretchable.

As interconnection conductors, first biocompatible metals will be used (e.g. sputtered Pt). , lateron the use of stretchable conductive polymers will be explored. First, single interconnection layer circuits will be developed, later on also multilayer structures will be fabricated, involving microvia formation and interlayer interconnection.

…biocompatible flexible electronics …
Lateron stretchable…

C. Component embedding and assembly

The flex will be given its high functionality by developing technologies for embedding and assembly of following components:

For passive components (resistors, etc.) first non-stretchable versions will be designed and developed, using metal conductors and resistors. In a more advanced stage also stretchable all-polymer versions will be considered. The inductors will allow wireless power and information transfer from the outside world to the implant or vice versa. As active components, ultrathin Si chips are encountered: The Target is embedding of 10µm thick Si dies into the flex.

Sensors: Existing sensors will be adapted (thinned) for assembly on flex and proper assembly and integration technologies will be developed. For some of these sensors direct contact (through a window in the polymer coating) with the human body environment must be foreseen

D. Feasibility demonstration

Towards the end of the proposed BioFlex project successfully developed technology building blocks will be used in the design, fabrication and testing of a limited number (out of a vast range of possibilities) of feasibility demonstrators in the biomedical field. Two applications outside and two inside the human body are foreseen:

Color electromyogram monitoring patch system and implantable monitoring device for incontinence treatment

Fetal ECG monitoring and respiration sensor for SIDS (Sudden Infant Death Syndrome) monitoring

For more information, contact the project coordinator:

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III The Partners

To have a quick information about the major markets, products and competences of the project participants, please take a look to their homepages:

Freudenberg Forschungsdienste KG	www.forschungsdienste.de	Dr. Christopher Klatt
Interuniversitair Micro-Electronica Centrum vzw	www.imec.be	Ir. Johan de Baets
Technische Universität Berlin	www.tu-berlin.de	Dr. Thomas Löher
Commisariat à l'Energie Atomique	www.cea.fr	Raphael Salot
Philips Electronics Nederland BV	www.philips.nl	Dr. Co van Veen
QPI Quality Products Int BV	www.qpigroup.com	Ir. Eugène Raemaekers
BE Semiconductor Industries NV	www.besi.nl	Dr. Ben van der Zon
Verhaert New Products & Services	www.verhaert.com	Ann van Mele
Laboratoires Urgo	www.urgo.fr	Laurent Apert
Fundico bvba	www.fundico.be	Dr. Gust Schols
Philips Innovative Technology Solutions	www.philips.be	Alain Bouffioux

If you want to get more information about other participants activities, to have direct contact during an event or to read more about the project, please see the information below.

Meet us:

- TextileTrends 2007,
  13 - 15 Februar, Berlin, Germany
  www.textile-trends
- Techtextil 2007,
  12-14. June, Frankfurt, Germany
  http://techtextil.messefrankfurt.com/frankfurt/de/
- Common Workshop: FlexStretch 2007,
  06.-07. September, Leuven, Belgium
  www.imec.be/flex-stretch

Read more:

- Melliand Textilberichte, Vol. 87,
  Issue 8, page 572
- Technische Textilien, Vol. 49,
  Issue 3, page 203
- Fashion Technics Today, 2006,
  Issue September, page 1
- FlexiDis Newsletter, 2006,
  Issue 2
- IEEE, Electronics Packaging
  Technology Conference 2006,
  page 1, 1-4244-0665

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Comments and information to the editor are always welcome.