

Welcome to the third issue of the PLACE-it Newsletter.

PLACE-it is a EC funded project within FP7 (ICT-248048), see: www.place-it-project.eu. In the project we develop a platform for conformable optical systems, based on light-emitting foils such as OLEDs, stretchable materials and/or textile fabrics. Within this integration platform, building blocks can be combined to form conformable opto-electronic systems such as smart bandages or (automotive) interior lighting applications.

This newsletter has the ambitious aim to support the dialog between the PLACE-it Consortium and the development communities, which are working on similar topics, respectively potential customers.

In the third issue we will present the bio-medical background of Blue Light Phototherapy and finalize the partners presentations. Additionally, we will show an analysis of the patent situation and close the newsletter with a short review of two major events: the Flex&Stretch Workshop end of 2011 and the TITIV conference beginning of this year.

Blue light phototherapy

“Blue LED-light as a new therapy option in back pain”

Back pain is a major health problem in the industrialized world. Next to headaches, it is one of the most frequently occurring pain complaints. Chronic pain can seriously limit people in their daily activities and results in significant economic and social costs. In most cases it is not occasional extreme strain on the body that caused the pain. Often it is more related to e.g. incorrect posture at the work place or insufficient exercise. Although the exact cause of chronic back can be difficult to identify, it is believed that at least a portion of these patients' pain may be the consequence of learned responses such as muscle tension to compensate for, or protect against further pain.

Therapeutic effects of blue light

Irradiation with blue light of 453 nm wavelength and an irradiance of 20 mW/cm² causes the release of nitric oxide (NO). Via diffusion, transnitrosation and systemic distribution through the bloodstream, the locally produced NO can even be transported to the muscle. NO-induced signaling pathways lead to a reduction of the intercellular calcium concentration, which results in a relaxation of the vascular smooth muscles.

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Facts about back pain

- About 37% of the global population experience muscular or joint pain which ranges from tolerable to intolerable.
- 19% of adult Europeans suffer from chronic muscle pain which affects quality of their lives.
- Most pain sufferers use a cocktail of pain management solutions but prefer drug-free alternatives.
- About 40% of pain sufferers view their pain management solutions as inadequate.
- Most muscle pain occurs in the neck, shoulder and back region.

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I The Project



Fig. 1: Philips-BlueTouch pain relief patch



I The Project

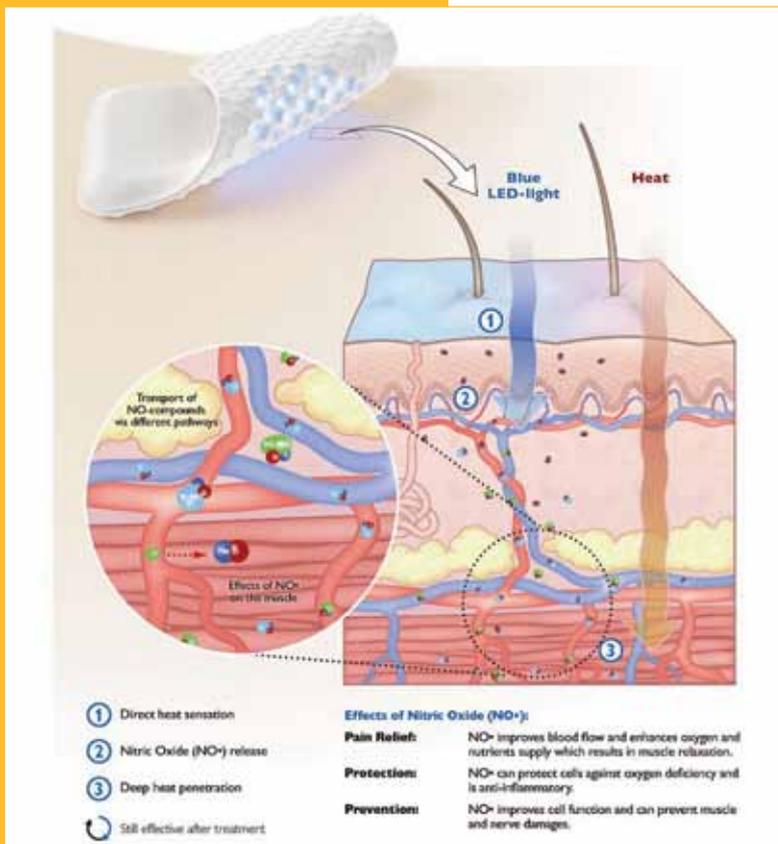


Fig. 2: Mechanism of pain relief



Fig. 3: Gas collection chamber (built by the University Hospital of the RWTH Aachen).

The outcome is explained by Professor Suschek (member Advisory Board of PLACE-it) as follows: "NO, which is released through the irradiation with light, improves the blood flow significantly. In fact, not only in the irradiated area, but also in areas, which have not been irradiated with light." Due to the increased blood circulation an enhanced supply with oxygen and nutrients to the muscle occurs. Furthermore, substances that trigger the experience of pain can be eliminated more easily. In addition, NO shows anti-oxidative, anti-inflammatory and anti-apoptotic effects and is therefore able to protect muscle and nerve cells from damages and can even prevent cell death. Moreover, the irradiation with blue LED-light leads to the release of thermal energy. This heat effect is found to be beneficially soothing for pain patients and also enhances the blood flow. The pain relief mechanisms of blue light are illustrated (Figure 2).

This new type of therapy offers the advantage of natural pain relief for back pain patients who are frequently treated with chemical substances. Blue LED-light stimulates the body's own processes, which sustainably diminish pain. In contrast to UV light, it is safe for skin treatment. Drug related side effects do not occur.

Wearable phototherapy

The development of LEDs opened up new possibilities for phototherapy. Their size allows integration in devices with new form factors such as wearable devices. The narrow emission spectrum allows selection of the optimal wavelength which makes therapies more effective.

Based on the insight of blue-light therapy we have designed flexible LED-arrays, integrated in bandages or patches that offer the therapy in a comfortable way. These devices will allow users to receive light treatment as they go about their daily business. Philips has now introduced (initially in the German market) a first-generation wearable light-emitting device for treatment of chronic (muscular) pain: the BlueTouch Pain Relief Patch shown in Figure 1. This device is built up with several textile technologies. We could say it is a first textile-based device to be used for light therapy with many textile properties incorporated. Within the PLACE-it project we will extend the textile functionality of this kind of devices by developing stretchable versions.

Measurement of bioresponse to light irradiation

In order to better understand the physiological effects of irradiation of the skin and to establish further evidence for the mechanism of NO generation in vivo, a small clinical study was executed within the PLACE-it project by the University Hospital of the RWTH Aachen in cooperation with Philips Research. In this study we measured the effects of LED irradiation with specific light spectra on blood perfusion, temperature development, and NO release in the human skin.

We designed and constructed devices for irradiation of the skin of healthy human volunteers in compliance with the EU requirements for medical devices. The optical output and the homogeneity of the LED sources were measured. Tests for electrical, thermal and radiation safety were performed. Finally, the devices were released for use in the clinical study with a Declaration of Conformity. At the core of the measurement set-up are special lamp units. These units can be mounted in a set-up for irradiation of the forearm or of the back.

In order to determine the effects on blood flow we irradiated for 15 minutes, investigating different wavelengths and different irradiances. Each condition was measured on 6 volunteers. Blood perfusion parameters were recorded before, during, immediately after, and up to 15 minutes after irradiation. Furthermore, the skin temperature, redness, and pigmentation were measured before and after irradiation. The upper arm and the outer forearm were used as non-irradiated controls for the inner forearm. The abdomen was used as control for the back. The subjective heat sensation was recorded by questionnaire.

Additionally, in a separated test set-up the NO release from the skin of the forearm of healthy volunteers was measured during 12 minutes of irradiation and up to 5 minutes after irradiation. The NO was collected in a gas chamber pressed to the skin and detected with a chemiluminescence detector.

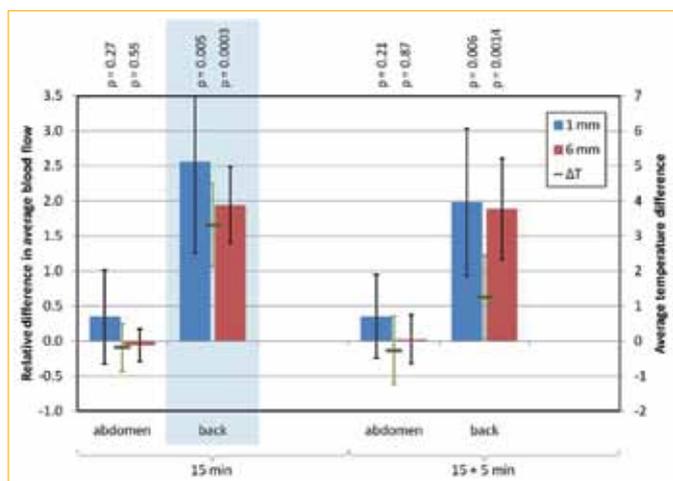
Results

NO was collected in the gas chamber in cycles. Each collection interval of 2 minutes was followed by a detection interval. From the detected signal we calculated a minimum and maximum NO release. The results of our analyses are shown in Figure 4 for blue light and Figure 5 for green light. The difference between blue and green irradiation is evident: a strong increase of NO release is seen for blue, whereas for green irradiation results and control are overlapping within the 'error bars' representing spread among volunteers.

After 12 minutes of irradiation the average NO release was a factor 17 larger compared to the control without irradiation (the constitutive level). An increase by a factor 8 occurred immediately after irradiation started. For irradiation with green light we did not find a significant effect with respect to NO release (Figure 5).

In Figure 6 are shown blood flow data for the back. For each subject we calculated the change in blood flow. The average of this difference is show in the graph as a fraction of the average blood flow before irradiation (at $t = 0$). The blood flow was determined at two depths in the skin: up to 2 mm (marked as 1mm) and 5 – 8 mm (marked as 6 mm). The results immediately after irradiation are shown over a blue background for clarity. A clear increase in blood flow is observed. The increased blood flow was sustained for more than 5 minutes after irradiation stopped. At the abdomen we did not observe a significant change in blood flow. Significance level was calculated with a paired t-test.

The volunteers did not report discomfort from the irradiation. On the contrary: the warmth was experienced as pleasant.



Conclusions and outlook

We have designed and built a versatile measurement set-up with special lamp units for use in clinical studies on the bioresponses to irradiation of the skin. In a first study we have demonstrated a significant increase in NO release and blood flow in response to blue light. Measurements of the blood flow increase at larger depths are in progress. We will report the outcome in the later phase of the PLACE-it project. We are looking forward to it!

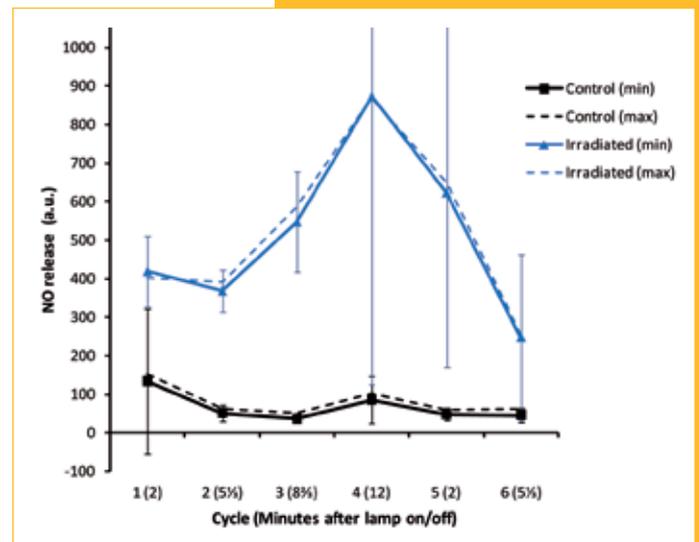


Fig. 4: Average NO release for blue light irradiation (blue lines) and control (black lines) as a function of cycle number. Time elapsed from the moment the lamp was turned on or off until the start of the respective detection interval is indicated in brackets. The lamp was switched off after four cycles. The solid lines represent the minimum NO release. The 'error bars' at each data point show the standard deviation of the data set. The dashed lines represent the maximum NO release.

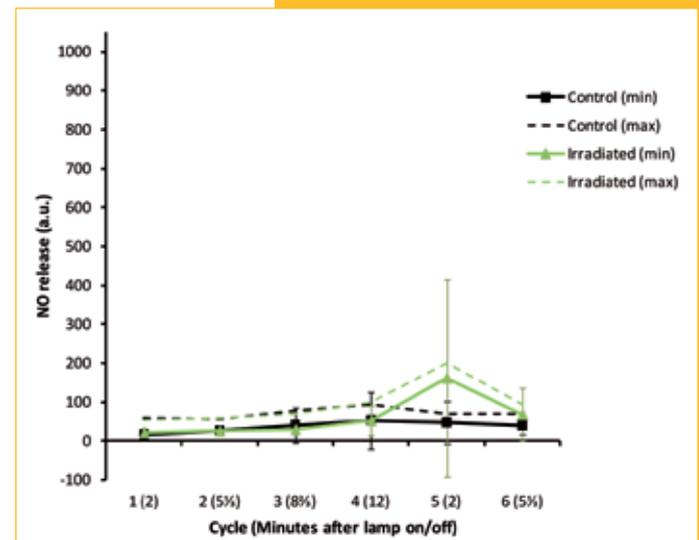


Fig. 5: Average NO release for green light irradiation (green lines) and control (black lines) as a function of cycle number. Representation further identical to Figure 4.

Fig. 6: Relative change in average blood flow (left axis) and average temperature change (right axis) for irradiation of the back with blue light. The abdomen functioned as non-irradiated control. Data are shown for $t = 15$ min, immediately after irradiation, and for $t = 20$ min, 5 minutes after irradiation has stopped. Results are given for two measurement depths: up to 2mm (marked as 1mm) and 5 – 8 mm (marked as 6 mm).

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II The Partners

OHMATEX

Ohmatex ApS is a Danish company that specializes in the integration of micro-electronics for textiles and garments, this is based on commercialising research developments in the area of advanced textiles and wearable electronics.



Fig. 7: Ohmatex has recently developed an Oedema sock which wirelessly measures the change in volume in the lower leg.

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Fig. 8: Headquarter Grupo Antolin

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Ohmatex also offers workshops as well as sparring with the aim of updating companies with the latest technological developments and generating ideas for further development.

Within the PLACE-it project, Ohmatex' function is to develop and design a textile connector that connects the flexible, stretchable materials and the foils to the textile substrate and connecting it to an external electronics/power source.

Grupo Antolin

Grupo Antolin is a Spanish manufacturer of vehicle interior components, focused on overhead, door, seats and lighting systems. Starting as a small shop manufacturer of ball joints during the 1950's it has evolved over the years to become a world leader in design, development and manufacturing of vehicle interior systems, with sales of EUR 2.5 billion in 2011 and more than 13,000 employees in 96 facilities over 25 countries. As one of the most important suppliers in the automotive industry, it works closely with the majority of the car manufacturers worldwide like Volkswagen Group, Ford Motor Co., PSA Peugeot-Citroën and Renault-Nissan as a Tier1 supplier.

Research and innovation is very important for Grupo Antolin, as a key for continuous improvement, customer satisfaction and product diversification to guarantee its leading position in the automotive industry. Some recent examples are development and manufacturing of magnesium parts, innovative fabrics, and nanotechnologies such as carbon nanofibres and Graphene.

In PLACE-it, Grupo Antolin integrates conformable optoelectronic systems to vehicle interior components, focusing mainly on the light. Achievements from PLACE-it technology platform will allow a step forward in integration and styling possibilities never seen before in the automotive industry. Forget about bulky and noisy plastic parts, inefficient and heavy incandescent lights, and think about energy-efficient LED and OLED light sources, which can be shaped, bended and stretched to any styling, allowing for light and thin vehicle interior trims. Welcome to the future in vehicle interiors. See more at www.grupoantolin.com.



Fig. 9: Seats
Fig. 10: Door panel
Fig. 11: Overhead

PLACE-it partner Imec

Imec performs world-leading research in nanoelectronics. Imec leverages its scientific knowledge with the innovative power of its global partnerships in ICT, healthcare and energy. Imec delivers industry-relevant technology solutions. In a unique high-tech environment, its international top talent is committed to providing the building blocks for a better life in a sustainable society. Imec is headquartered in Leuven, Belgium, and has offices in Belgium, the Netherlands, Taiwan, US, China and Japan. Its staff of more than 1,750 people includes over 550 industrial residents and guest researchers. In 2009, Imec's revenue (P&L) was 275 million euro.

The work in PLACE-it is covered by the associated lab 'Centre for Microsystems Technology' (CMST), located at Ghent University. This is a heterogeneous smart system integration center primarily using polymer, rigid, flexible and stretchable integration technologies. A strategic investment plan, set up in 2010, aims at the implementation of a technology platform for heterogeneous polymer system integration. This technology platform necessitated an extension of CMST's cleanroom facilities with 3 extra processing bays. The construction of the new processing bays started in 2011 and is expected to be finished early 2012. Simultaneously new equipment was ordered to complete a large area electronics processing line. Among others this line will include a laser direct imaging apparatus for fine patterning (1 μ m), a femto laser ablation installation for micro structuring and micro injection molding equipment. In order to comply with the research topics of CMST's key research partners, CMST's research domains were reorganized. At present CMST counts 7 technology domains: advanced packaging, stretchable interconnect, ultra thin-film chip package (UTCP), polymer structuring and microfluidics, optical interconnect and laser technology, smart power and display technology. These research domains cover the following application domains: biomedical & health, telecom, energy, ambient intelligence and display & lighting. In PLACE-it, the main technological contributions are situated in the field of stretchable electronics and the integration of these conformable modules into textiles. CMST has developed technologies for realizing conformable devices in the frame of the European project Stella. It can be stated that currently, CMST has the most reliable, printed circuit board (PCB) based technology. CMST is involved in 3 demonstrators situated in the medical and automotive area where it applies its know-how on conformable systems. Furthermore, within PLACE-it, CMST is further characterizing its technology by cyclic endurance testing the devices and subjecting them to washing tests, in order to make these devices washing proof.



Fig. 13: RGB LED integration and OLED tile integration, both in stretch technology in combination with textile.

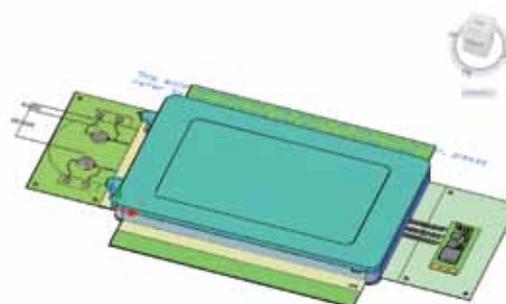
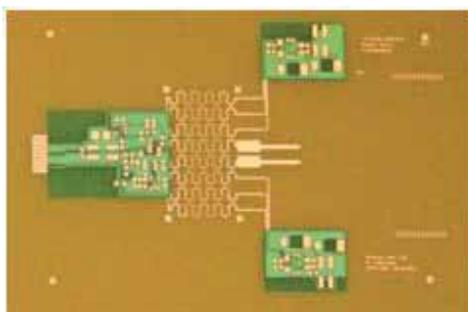


Fig. 14: PLACE-it demonstrators in progress: Stretchable renal function monitor (left) and sunvisor (right).



Fig. 12: Imec buildings in Leuven (B)

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Patent Statistics

A patent review is essential to develop a patent strategy, to get an insight into the state of the art, to evaluate the maturity of a technology and to avoid duplicate research and patent violations. Furthermore, patents are an indicator not only for the research activities, but also for market demands.

Patent reviews and statistics are part of the PLACE-it project. Hence, the department Center of Information and Documentation (ZID) at FFD has compiled a patent statistics on "LED on stretchable fabrics" to screen the worldwide research activities in this field. The summary of the results are presented in this newsletter.

The intention of a patent statistics is to identify key players, to look for the technology segments to which the patents are assigned, and to determine the countries as well as the markets the patents are referring to.

Based on a keyword selection the DERWENT World Patent Index has been used. The advantage of this database is the availability of standardized English abstracts and the possibility to analyze patent families which are related to the respective invention.

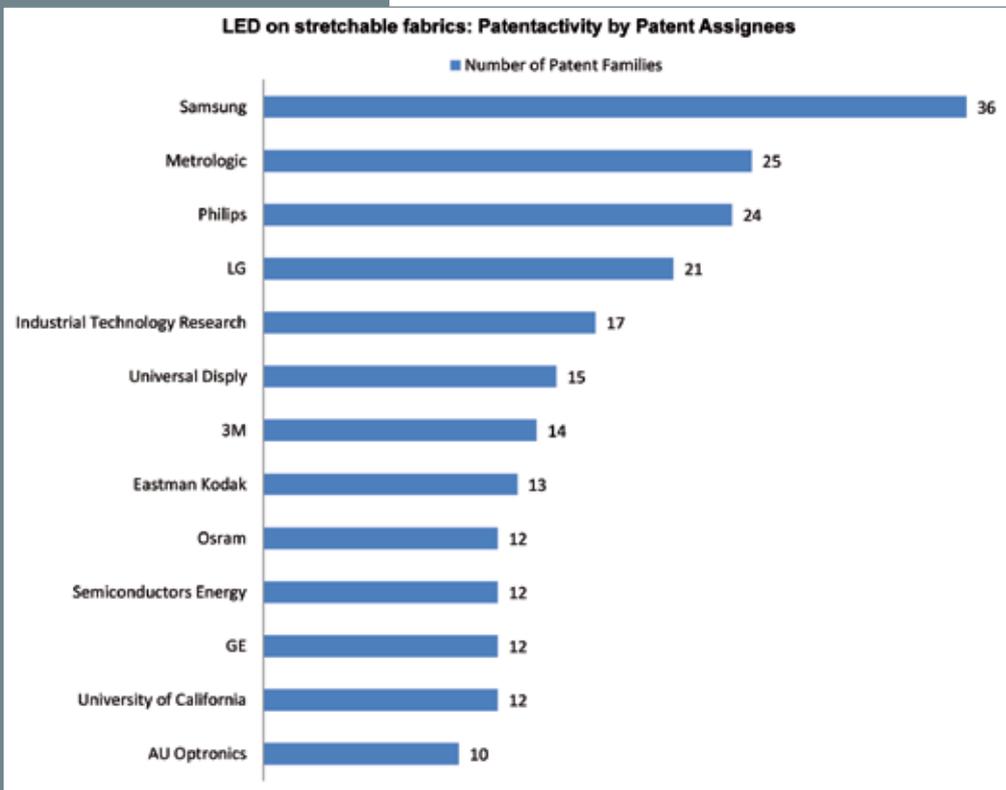


Fig. 15: Patent Assignees

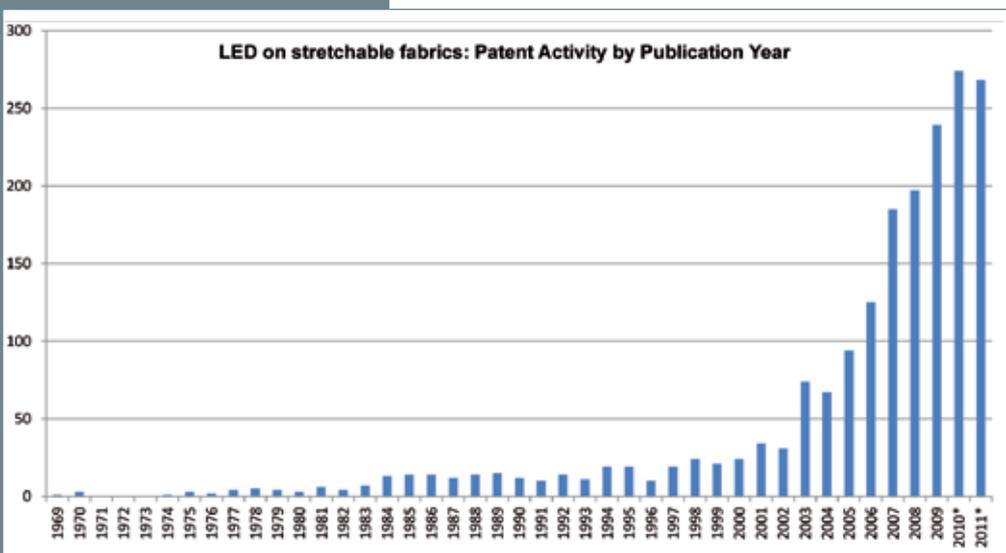


Fig. 16: Patent Activity

Figure 15 shows the ranking of the TOP 13 companies active in this field. For the patent statistics on "LED on stretchable fabrics" the key patent assignee is Samsung directly followed by Metrologic Instruments, Philips and LG. All of these companies are related to display research as they are (or were) large manufacturers of displays.

3M and Osram are engaged in supplying materials or light source. Here, the basis substrates are the key factor for large and thin devices.

The annual trend of disclosures per publication year are presented in Figure 16. There has been a continuous research on stretchable electronics since the mid eighties (1984 – 2000) on a lower level. However the statistics indicates, that the patent activity grew rapidly since the beginning of 2003. Additionally, as there is a gap of 1,5 years between the application and the publication (filling a patent and its disclosure), there are more publications to be expected for the years 2010 and 2011.

A third aspect of patent statistics is the distribution to the countries worldwide (see Figure 17). With 34% of all publications the Asian countries are the most active one, namely Japan, Korea and China, followed by US. This reflects both the strong research and manufacturing activities and the importance of the Asian and US market. It is the aim of the PLACE-it project to increase the European percentage of these patents.

Finally, Figure 18 gives an overview on the DERWENT codes. The top 3 of these codes, assigning patents to fields of technical classes, are technological fields of research not markets and applications. This is an indicator for a research field not yet fully developed, as mature technologies usually generate more application patents.

However, not all patents included in this statistics will be relevant to our project. The keywords have been selected relatively broad to avoid small numbers.

In a subsequent second step the retrieved patents will be analyzed for technological relevance to our field of research.

Summarizing the results presented here, it is quite obvious that the technological field is very active. The statistics as well as the detailed analysis will be updated regularly during the project and a final overview will be given mid 2013.

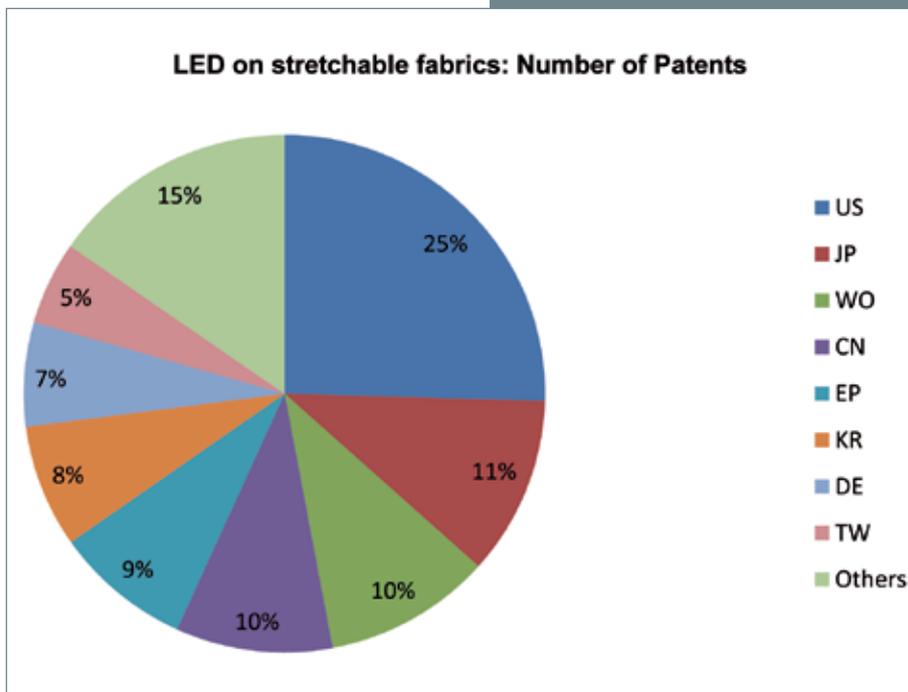


Fig. 17: Patent Countries

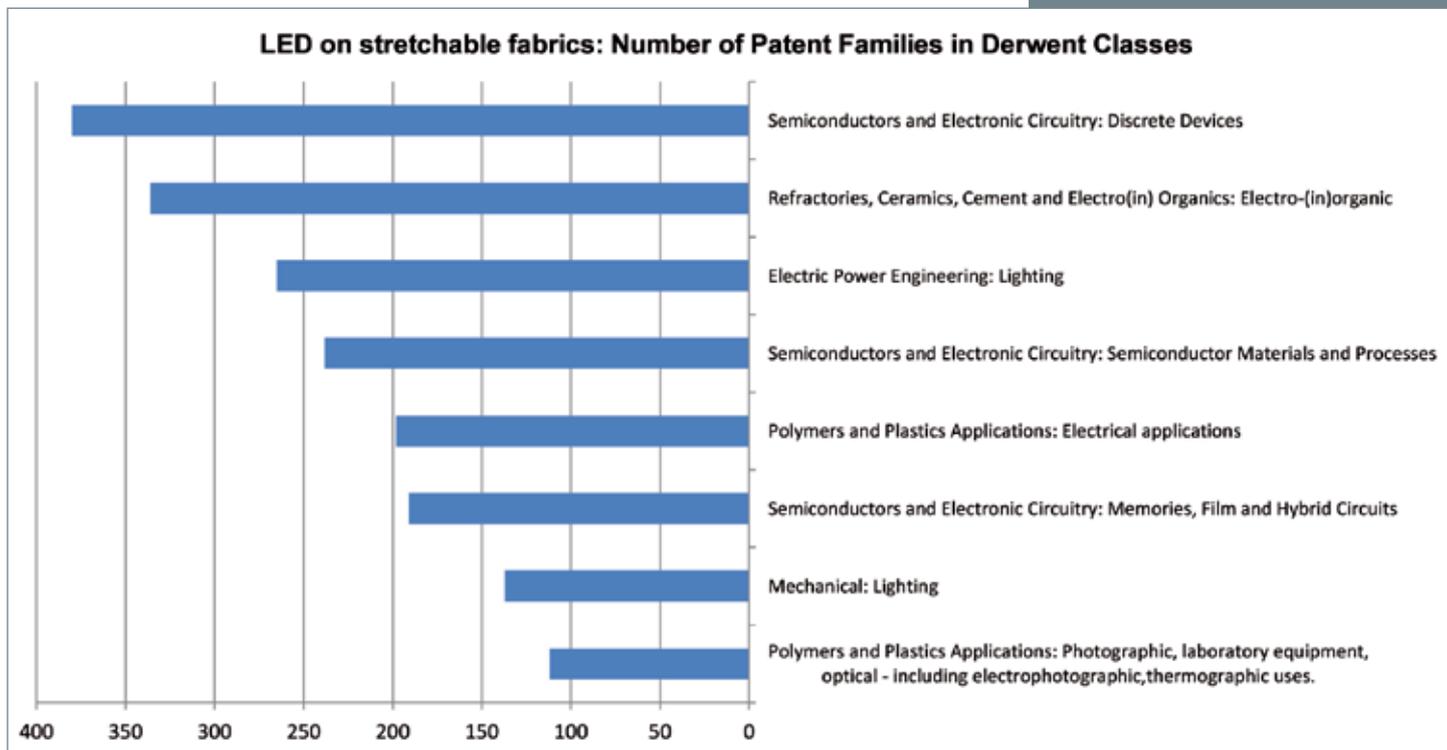


Fig. 18: Derwent Codes

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Report on the 3rd International Workshop on Flexible & Stretchable Electronics

Located in the inspiring surrounding of Berlin Dahlem (the science city), people from all over the world took part. 104 participants, 7 keynotes, 28 presentations, about 20 posters and a lot of informal discussions are the key numbers to report from the 2-days 3rd Flex&Stretch Workshop 2011. The networking and discussions were focusing on maturity of technologies and proposed roadmaps for applications. Several bi- or trilateral follow up meetings were established along the way.



Fig. 19: Participants of the FlexStretch Workshop 2011

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Finally, there was a common understanding that this event is the right place to bring together the important players in this field.

We are looking forward to planning the 4th event scheduled for end of 2013.

Organizing team:

- Johan De Baets
- Wim Christiaens
- Christopher Klatt
- Thomas Löher
- Liesbeth van Pieteron
- Jan Vanfleteren

Report on the TITV Conference 2012

Roughly 150 attendants participated in this year's TITV conference under the motto "Integration of multiple functions via textile microsystems technology" in Zeulenroda. As in previous years, it was jointly organized with the Fraunhofer Institute for Reliability and Microintegration (IZM), Berlin.



Fig. 20: Speech at TITV Conference 2012

Covering the general topic of textile microsystems technology for the fourth time, the convention again addressed a variety of topics such as technologies for flexible electronics, automotive textiles of tomorrow or the integration of electronic components in textiles. Among other speakers from backgrounds as diverse as electronics, architecture and automotive, Koen van Os, Philips Corporate Technologies Eindhoven, lectured on "New categories of electronics based on textile properties". In his speech he introduced the European project PLACE-it, involving both the TITV Greiz and Philips, which deals with the investigation of large area conformable electronics, and presented the three basic technologies of the current study. Dominique Vicard, CEA-Leti, Grenoble, took up the topic and presented the project "PASTA - Integrating Platform for Advanced Smart Textile Applications" which focuses on the development of new electronic packaging and interconnection technologies for the manufacturing of large area smart textiles. Dirk Zschenderlein, head of the R&D department at the TITV Greiz, rounded off the subject by informing the audience about possibilities for the automatic interconnection of electronic elements with textile substrates.

The TITV Greiz was furthermore presented by its scientists Dr. Andreas Neudeck and Dr. Wolfgang Scheibner who lectured on "The development of textiles with electroluminescent properties on the basis of inter-digital structures" and "SeatSen - textile-integrated sensors for the seat-occupant detection", respectively.

Again, the conference served as a platform to share views on the opportunities and limits of the integration of electronics into textiles. Several exhibitors presented their latest product innovations at the accompanying show.

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Please visit the website
www.place-it-project.eu for
upcoming events.