FIRST FOIL BASED OLEDS ON TEXTILE
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A place for wearable electronics

A new project based in The Netherlands aims to successfully develop electronic textiles products for a range of applications. **Koen van Os** introduces the project and outlines the reasons for its initiation

Could you outline the background of the Platform for Large Area Conformable Electronics by InTegration (PLACE-it) project? What was the motivation behind it?

About five years ago, LED technology became readily available for integration into wearable products. There was a similar demand within the automotive interior industry, which sought to integrate LED in large panels. LED costs became affordable and organic LEDs (OLEDs) were appearing on the horizon. There was a general expectation that these new components could be integrated into everyday products.

Adapting technology solutions to operate in close contact to human skin requires a different kind of 'comfort' thinking not compatible in conventional electronic product development. Experts from a variety of sectors have to be consulted. The idea of the project is to bring these people together to generate discussion and collaboration.

How is the project structured?

The project was initiated by Dr Liesbeth van Pieterson from Philips, with a structure planned from the outset. First, we evaluated application descriptions and needs, and then defined building blocks; this was followed by an intense period of creating, testing and evaluating these potential building blocks. Next, we brought them all together in so-called integrated testing vehicles – these were used to test subparts of the final demonstrators. We held discussions with advisors, conducting rigorous product testing in line with our requirements.

The demonstrators are almost complete and we are confident they will meet expectations. This structure yields application for all directions chosen by the project (from wearables to car body).

PLACE-it is focused on the end-user at all times. How does this approach influence the project as a whole?

People involved in the project have different backgrounds and aspirations, and identifying the individual needs of the end-user is important for creating a common vision. Feedback from end-users dominates the decisions we make.

Using phototherapy as an example, organisation is centred around the Philips BlueTouch project, which was initiated during product development to create a device for patients with back pain. This product development brought an enormous amount of needs and end-user feedback to PLACE-it.

Can you discuss the development of wearable textile-based phototherapy systems? How has PLACE-it contributed to the development of Philips BlueTouch?

Philips BlueTouch has been clinically proofed and is now a CE certified medical device. Several of our partners also contributed to this investigation. Special measurement set-ups at RWTH Aachen University, Germany, have proved blue LED light affects biochemical processes in our

When technology meets textiles

In recent years, the science and applications of smart materials has developed significantly. Hoping to take this industry to the next level, the **PLACE-it** consortium is creating innovative electronic products for such areas as human health and the automotive industry

SMART MATERIALS – those which sense and respond to environmental conditions and stimuli – are on the rise and are gaining more attention than ever before in a wide range of disciplines. Already, these smart textiles or 'e-textiles' are transforming the way we think about materials and their potential place within sectors such as healthcare, education, public safety, fashion, entertainment and interior design. As with many smart technologies (phones, for example), these innovative textiles are often multipurpose, and can adapt to their surroundings and operate autonomously.

As e-textiles represent a relatively new industry, research and prototypes are still in the early stages of development; however, their potential to increase competitiveness in Europe is an exciting prospect for many researchers. Hoping to explore this evolving class of electronics further is Koen van Os who, in coordination with Dutch electronics giant Philips and 11 other partners, has developed the Platform for Large Area Conformable Electronics by InTegration (PLACE-it) project. With a budget of €16 million, PLACE-it is one of the largest ICT projects currently being supported by the EU Seventh Framework Programme (FP7).

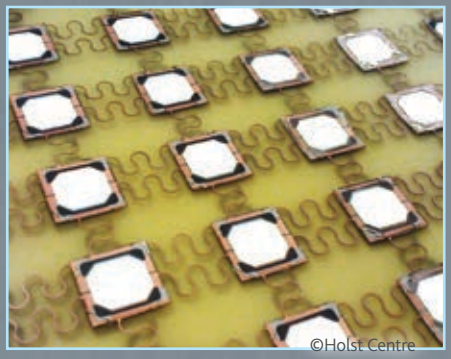
The team is conducting intelligent foil, stretch and textiles research to develop a range of unique electronic products that benefit various sectors: "We will present industrial design rules and recommendations to make large area light emitting, electronic and sensing surfaces. It is about creating technologies that can cover 'skins', from human skin to automotive, and we are even looking at building skins, ie. architecture. We are also evaluating, for example, phototherapy and biochemical sensor technologies," van Os outlines.

WHY CONFORMABLE ELECTRONICS?

Until recently, electronic systems were generally flat, rigid and inflexible; designs that have been appropriate for devices such as phones and computers, but not for our bodies. For wearable technologies, researchers must take into consideration the human form: the way it moves and bends, and its softness. Product designs must therefore be conformable (stretchable), breathable, comfortable, robust and lightweight. "Uncontrolled movement and body shape are demanding on technologies, and a certain percentage of elasticity is required if electronics are to fulfil this demand. Without this elasticity, large area electronics create air-gaps, pressure points, sharp folding lines and cracks," van Os explains. Conformable electronics have a wide range of promising applications, but the team is predominantly interested in their ability to cover human or automotive bodies, almost like a 'cyber skin'.

BEST OF BOTH

Bringing together expertise from academic and industrial sectors, the PLACE-it consortium benefits from both clinical proficiency and advanced technical knowledge. Their main objective is to co-develop flexible large-area technologies that are, for example, foil- and light-based, stretchable and fabric-based, and that interconnect to create high-quality optoelectronic systems with unique technical properties and performances. PLACE-it offers something unique in that it examines flexible, stretchable and fabric technologies simultaneously for heterogeneous integration. To reach this goal, the team will create conformable devices by comparing the best features and integrating the most effective technologies.



A STRETCHABLE ELECTRONIC SYSTEM

bodies. PLACE-it provides the textile-based building block for the project.

The PLACE-it consortium has a diverse range of members spanning both academia and industry. Has this variety strengthened the consortium as a whole?

The consortium has a shared goal to involve all interested parties in addressing issues as they arise. However, this is not limited to the consortium itself, and input from external players is always welcome. Collaborating further afield gives us opportunities to disseminate results in new directions. Our partners come from various backgrounds and industries, which will greatly strengthen the outcome of the project.

How do you predict the field of wearable electronics and e-textiles will develop over the coming years?

There are many opportunities for this technology. Amazingly, it could cross from reality into the virtual world, which is currently developing at a very fast rate; the internet offers many solutions every day. PLACE-it's conformable electronics provide another expression of this virtual world. It makes sense to apply this idea to healthcare-related applications, but fashion and self-expression are still to be discovered as an application area.

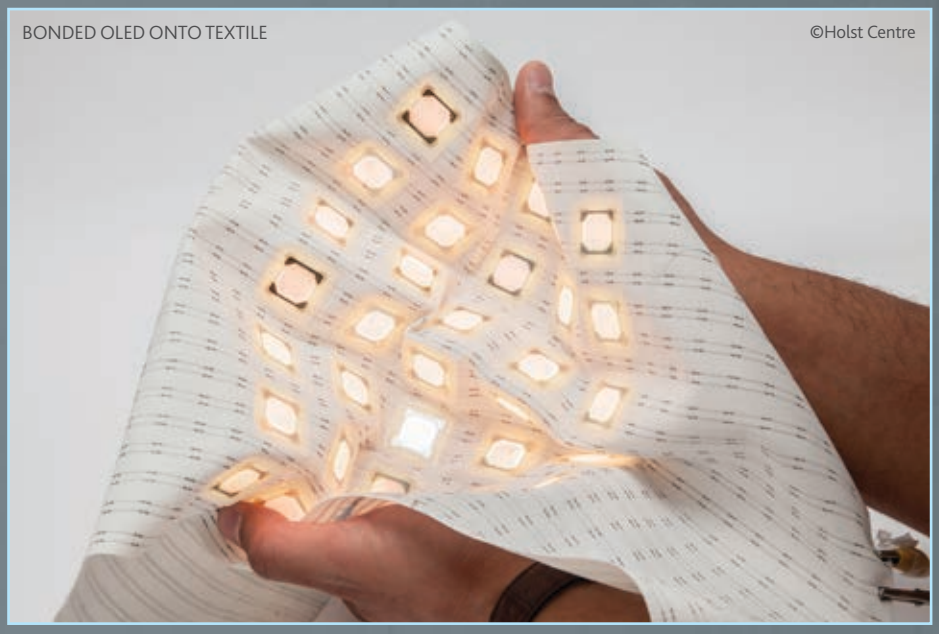
INNOVATION, INNOVATION, INNOVATION

Van Os is working with leading electronics company Philips, which is coordinating the PLACE-it project through its international Philips Research organisation. Philips Research has three main research programmes – healthcare, lifestyle and lighting – each of which enables profitable growth for Philips by bringing rapid innovations to market.

From diagnostic imaging to patient care, home and personal healthcare to healing environments and services, the Philips healthcare programme creates innovative technologies to alleviate the pressures of healthcare systems and prepare for an ageing population, focusing on patients and care providers to find solutions to current healthcare issues. Examples include Philips BlueTouch, a device which exposes the body to blue LED light, causing the release of nitric oxide (a known pain relief); a blanket to treat neonatal jaundice; and a light-emitting device worn on the wrist to treat carpal tunnel syndrome.

In addition, the lifestyle programme identifies methods to improve quality of life by focusing on consumer requirements such as personal care, and home and interactive living. Their lighting projects look at ways to generate sustainable electricity through innovative methods including LED conversion and systems, advance light delivery and effective energy management.

With laboratories in The Netherlands, Germany, the UK, India, the US and China, Philips Research is in a position to perform high-level research and create meaningful innovations that improve lives not only in Europe, but globally. The company will provide its knowledge of coordinating European projects, as well as electronic design and optics, to progress the project further.



BONDED OLED ONTO TEXTILE ©Holst Centre

LEARNING APPROACH

Since the project's inception and throughout each process, van Os and the PLACE-it team have focused on the requirements of the product's end-users, listening to advice and feedback from stakeholders to ensure their products met specifications and were tailored and adapted accordingly. This has enabled the group to work effectively and with decisiveness. They are confident this approach could be applied to a number of other projects.

By synchronising clinical insight with the physical realisation of potential developments, the researchers have been able to perform each process and stage reliably and with speed. The team has also identified that extensive, detailed manufacturing and industrialisation are crucial to the project's success.

GET INVOLVED

Now coming to the end of its four-year duration, the PLACE-it consortium has set the benchmark for e-textiles, bringing great potential and new ideas to this growing industry. "PLACE-it has introduced a new method of application thinking based on stretchable technologies that could change products and markets in the near future, and the consortium invites other companies and institutes to set boundaries even further – please make contact if you are interested in certain parts of this project or in forming collaborations!" van Os states.

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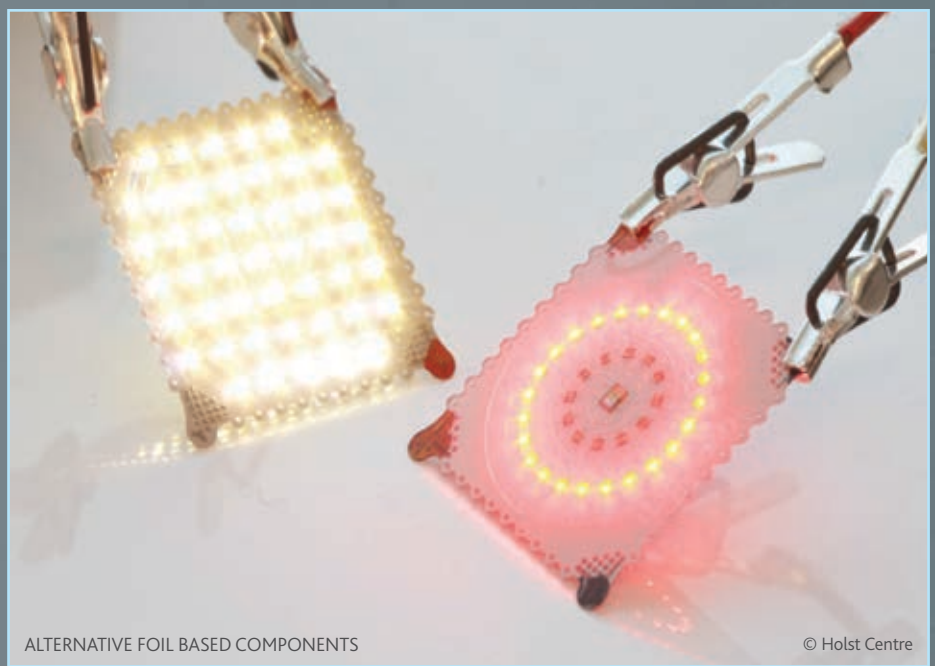
A UNIQUE PLATFORM FOR EFFECTIVE LIGHT-BASED THERAPIES FOR TREATMENT OF BACK PAIN.

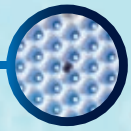


ALTERNATIVE FOIL BASED COMPONENTS © Holst Centre

PLACE-it applications

The PLACE-it consortium has developed five demonstrators with advanced technologies to showcase its expertise in the e-textiles sector. Below, we highlight some of their most successful products to date

BLUE LIGHT THERAPY



Arguably the most innovative and successful product developed by the team is the stretchable Blue LED Light Therapy for effective pain relief. Blue Light enhances the body's release of nitric oxide – which possesses pain-relieving qualities. 50 per cent stretch will be demonstrated in devices so they can be worn, for example, on the back. Clinical evidence suggesting this therapy works has already been established, and the device is comfortable to wear all day, every day.

In addition, this mobile phototherapy device could also be used in other significant ways, eg. as a blanket to treat neonatal jaundice or worn on the wrist to treat carpal tunnel syndrome. "Our technology is bridging the gap between typical healthcare treatment (hospital appointments, for example), and personal, self-motivated care," van Os adds.

SMALL OLEDS

The project has developed groundbreaking e-textile technology to demonstrate the integration of organic LED (OLED) components on textile in large format. The group has created light-emitting surfaces that maintain the experience of ordinary textiles (such as blankets and bed linen), but that are also designed to change colour instantly or sparkle. These products could transform the way we think about interior design spaces, in both formal and informal contexts.

BIOMEDICAL TECHNOLOGY

Using OLED technology, a flexible fluorescence measurement device has been created to assess the elimination kinetics of the renal marker FITC-Sinistrin (water-soluble fructan linked to fluorescein-isothiocyanate). "Status and functionality of kidneys can be measured by this revolutionary device, which uses PLACE-it technology to find the way to low-cost, high-comfort solutions," van Os explains. The team hopes this product will help to detect end stage renal disease (ESRD) earlier and more consistently.

AUTOMOTIVE LIGHTING & SKIN

In line with their light-emitting surfaces for interior design, PLACE-it is also developing automotive parts based on novel lighting technologies that are functional, sustainable, energy-efficient and cost-effective. Innovative interior designs for features such as sun visors are now being redesigned based on the team's light emitting surface technologies.

The team has also invented automotive headliners and ceilings that act as a skin to the body of a car. "Those large mechanical parts which now have lighting functionality can be produced in a cost-effective and reliable way by PLACE-it technologies," van Os illustrates.

INTELLIGENCE

PLACE-IT

OBJECTIVES

To analyse, develop and implement technology for the proper combination of functionalities in foil, stretchable and fabric substrates, resulting in conformable opto-electronic systems. PLACE-it aims to develop:

- An integration platform of foil, stretch and fabric technologies with opto-electronic functionality
- Foil, stretchable and fabric-based devices for light emission, electronics, sensing and with interfaces to other technology building blocks
- Design guidelines to implement the technology platform in a broad range of applications
- Demonstrators, ie. optoelectronic systems, showing the possibilities of the technology platform

KEY COLLABORATORS

Philips Research Eindhoven (coordinator) • **Netherlands Organization for Applied Scientific Research** (TNO – HOLST) • **Technische Universitat Berlin** • **Freudenberg Forschungsdienste KG** • **Interuniversity Microelectronis Centre** • **Centexbe** • **TITV Greiz** • **Philips Lighting** • **Grupo Antolin** • **InnovationLab** • **RWTH Aachen** • **Ohmatex Dk**.

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KOEN VAN OS received his Master's in Precision Engineering from Eindhoven University of Technology in 1995. He joined Philips in 2001 as a Technologist in the field of electronic interconnection technologies and later worked as Engineering Manager at Philips Lumalive, developing LED textiles in wearable applications. Since 2010, he has explored electronic textiles at Philips Research and is now Project Coordinator of the PLACE-it project.