NFC ENABLED
- SEE INSIDE FLAP -

THIS BROCHURE IS NFC* ENABLED
PLACE SMARTPHONE HERE TO EXPLORE THE COLLECTION VIDEO

OR WATCH ONLINE AT
NFC.STOLL.COM/VIDEO/STOLL_PERFORMANCE_PLUS.MP4

*NEAR FIELD COMMUNICATION

STOLL PERFORMANCE+

Our game-changing CMS ADF technology has opened up a whole new world of possibilities in performance knitwear – from heat and moisture control, to compression and 3D pre-shaping – taking traditional fabric construction to another level. Our weave-in and plating applications have boosted the development potential of performance knits even further, resulting in the Performance+ collection.

Smart textiles are a global trend. By partnering with leading scientists and tech companies from different disciplines, we've embedded electrical heating elements, NFC chips and photovoltaic cells into knit structures. With flat-bed knitting, we can now knit circuits and conductive yarn directly into the fabric precisely, right where they're needed, in a fully automated way.

We want to express our sincere thanks to our industry and education partners, for inspiring us.

Welcome to the future.

Jörg Hartmann
Head of Fashion & Technology

KNITTED-IN MESH STRUCTURE FOR
IMPROVED MOISTURE TRANSFER

1610003 · · · CMS ADF 32 BW · · · E 18M.16

· Fully Fashion sports bra, knitted in one piece
· Pre-shaped cups created by 3D goring technology and variable stitch density
· Double layer construction technique with different purl stitches
· Body mapping on front and back layer, using Stoll-ikat plating®
· Grin through of back layer, for a 3D look


KNITTED-ON POCKET FOR
REMOVABLE NFC CHIP

BALACLAVA

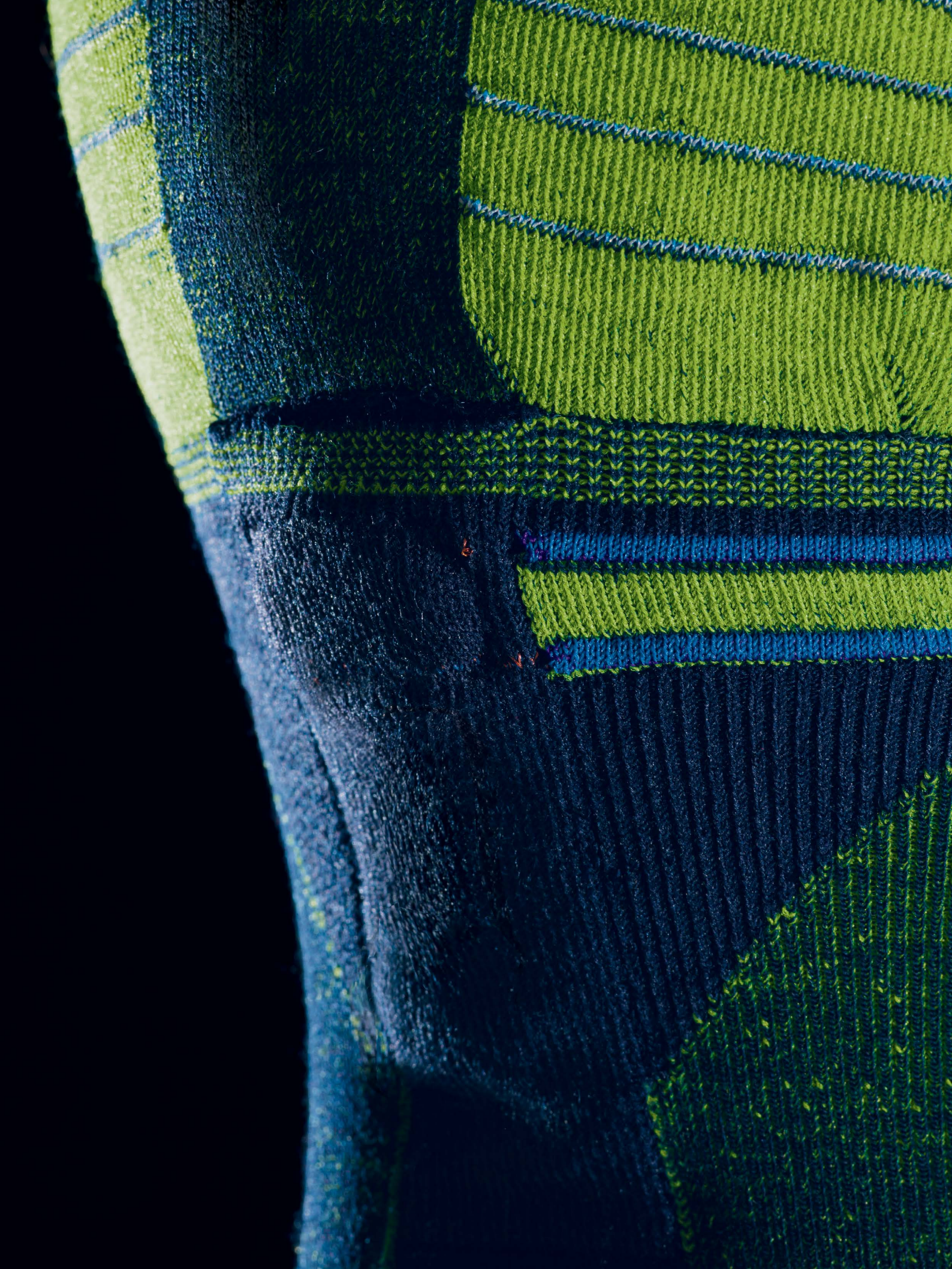
1610014 · · · CMS ADF 32 BW · · · E 18M.16

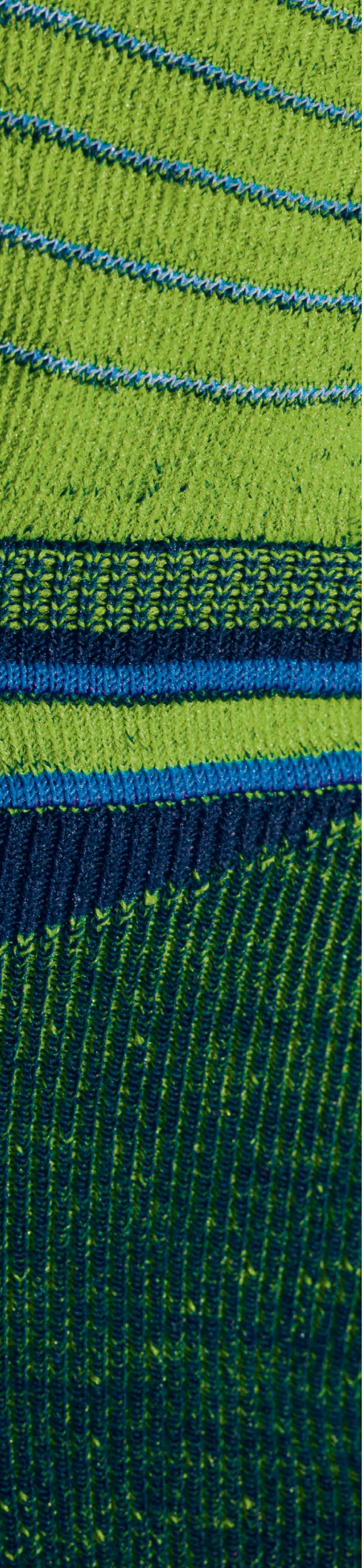
- Stoll-ikat plating
- Balaclava knitted to shape in one piece
- 3D preshaped using goring technique to fit the human head
- Knitted-in reflective stripes using Selective Plating, for passive visibility
- Knitted-in NFC chip

Explore the features at: nfc.stoll.com/video/stoll_performance_plus.mp4

HEATED MESH STRUCTURE


CELL BATTERY SOCKET





HEATED MESH

Designed and produced using our latest flat-bed technology, our Balaclava is engineered for life outdoors, in cold weather conditions. Whether running, skiing or resting, it's designed to protect the face and neck – both through windproof textile qualities, as well as the built-in heating area around the mouth, to warm the cold air before it hits the lungs.

Using state of the art flat-bed knitting technology, we're able to knit the heating wires directly into the fabric itself, exactly where they're needed, in an outstanding fully automated manner.

There's a built-in power socket containing a plus and minus pole to connect to a cell battery. When you insert the battery, the power turns on and the area around the mouth starts to warm up.

INNOVATIVE E-TEXTILES

A conversation between
Prof. Dr. Tilak Dias
and **Jörg Hartmann, STOLL**

Nottingham Trent University – Arkwright building

What drove you to become a scientist in the field of electronic textiles?

Since humans first invented textiles many millennia ago, they have gone through many evolutions. During the last century in particular, the focus has been on improving the functionality of a textile. This has led to the development of fabrics which are capable of stopping a bullet travelling at supersonic speeds, fire retardant fabrics and impact- and cut-resistant fabrics. All of these things have been achieved through chemical processes and advances in polymer science.

Textiles are now going through a new evolution, integrating electrical systems and electronic devices – which, done properly, will introduce intelligence to materials, for the first time.

Before obtaining my textile engineering degrees (Dipl.-Ing. from TU Dresden and Dr.-Ing. from the Universität Stuttgart), I studied electronics engineering. I think these two engineering backgrounds were the main impetus for my research.

What have been your most important or exciting findings, so far?

There are a number of different approaches to producing electrical and electronic textiles. These include inserting pre-packaged electronics into pockets, stitching components to the surface, integrating functionality using conductive threads, using printing technology or integrating electronics into belts or straps. However, the ultimate aim would be to integrate electronic functionality into textiles without compromising their softness, flexibility and conformability. To minimise costs, it's also essential that electronic textiles can be produced on conventional equipment. A more novel approach is to bury semi-conductor chips within the very fibres of the yarn. As a textile conforms to a shape, some parts bend and some go into shear deformation. Both factors are important for drape and conformability. Knitted and woven textiles are able to conform to a shape as they bend and shear. For example, thin polymer

films can bend – but because they can't shear, they buckle and crumple rather than conform to a shape. The approach that I am pioneering at Nottingham Trent University is to connect semi-conductor chips to fine copper wires and incorporate them within the fibres of a yarn. The chips are then protected by polymer micro-pods. Free fibres between micro-pods help retain the textile's softness, flexibility and conformability. The electronically functional yarns are then knitted using conventional textile equipment.

How do you see this technology being used in the future?
We envisage the development of new fibre-based transducers, to be used in wearable computing and the next generation of SMART clothing. This SMART clothing will be able to measure the body's vital signs: ECG, breathing rate, breathing patterns, skin temperature, perspiration, bodily electrical activity, body motion and gesturing. The potential for clothes that can monitor vital signs like this to improve both the quality of life and health of patients and the elderly is immense.

What do you think are the biggest obstacles to engineering and designing smart clothes these days?
In my opinion, there are three factors: the cost, the difficulty of making the sensors unnoticeable, and the energy/power required for the electronics.

Why have you chosen the latest STOLL machine technology CMS ADF 32W for your future research?
We think the modern flat-bed knitting technology provides an excellent platform for research and development of complex, 3D-shaped knitted products due to computer-controlled needle selection, needle bed racking and yarn carrier selection. The belt-driven yarn carrier control in CMS ADF 32W and direct yarn delivery allow us to position the yarn onto the needles precisely, thus enhancing intarsia knitting techniques. Also, the ability to lay in a predetermined length of yarn on CMS ADF 32W machines would make it possible to create the transducers and conductive pathways in a knitted garment which make it possible to monitor the vital signs of the wearer.

How will electronic knits change or influence the textile chain?
Over the last decade, there has been considerable interest in even more sophisticated technologies. Smart and interactive textiles are a new emerging sector and growth is forecast at 40% annually and to reach US$2.5 billion by 2021. The ability to create e-textiles using computerized flat-bed knitting technology, such as STOLL CMS ADF 32W, would influence the textile value chain.

Prof. Dr. Tilak Dias

ABOUT

Set up by Professor Tilak Dias in 2010, the Advanced Textiles Research Group (ATRG) is a thriving research group at the UK's Nottingham Trent University. Housed within the university's School of Art & Design, the research group works closely with its colleagues in art and fashion, growing within the School since its creation.
The ATRG's research runs along two main lines: Electronic Textiles and Yarns, focused on integrating electronics into yarns and textiles – and Flexural Materials, focused on advanced knitted and woven structures, elastomeric composites and bio-realistic modelling.
Professor Dias, who still leads the group today, has over 30 years of research experience in this area – with extensive contacts across both the industrial and academic worlds, within the UK and around the world.

1610001 · · · CMS ADF 32 BW · · · E 18M.16

· Fully Fashion running tights, knitted in traversal direction
· Entire shape made using 3D goring technology
· Body mapping with Stoll-ikat plating® on purl stitch
· Waistband made with Stoll-weave-in® and goring technique

Explore the features at: nfc.stoll.com/video/stoll_performance_plus.mp4


KNITTED-IN NFC CHIP
ACTIVATES MOBILE FLASH APP
INTEGRATED POCKET
IN WAISTBAND
FLASHLIGHT FOR ACTIVE
VISIBILITY, CONTROLLED
BY NFC CHIP


COMPRESSION SECTIONS
AROUND THE KNEES
REFLECTIVE YARNS, FOR
PASSIVE VISIBILITY

1510116 · · · CMS ADF 32 BW · · · E 18M.16

· Tubular sports cuff, knitted to shape using goring technique
· Artwork made with Stoll-ikat plating®
· Abrasion protection element in Selective Plating technique
· Integrated opening for watch on left cuff
· NFC chip knitted into right cuff

Explore the features at: nfc.stoll.com/video/stoll_performance_plus.mp4

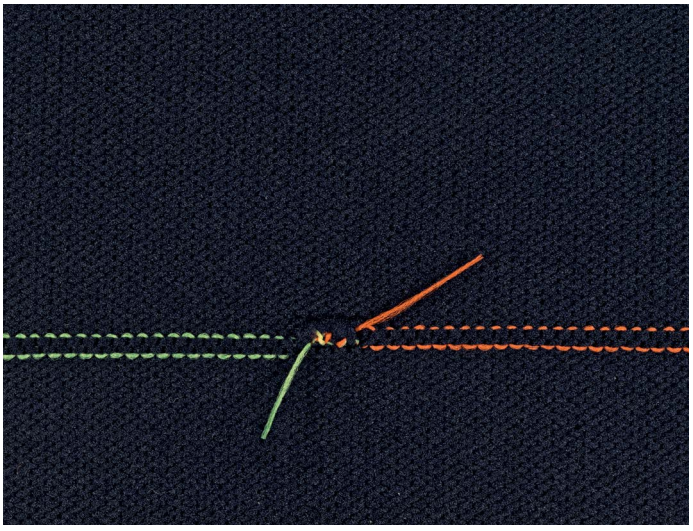

KNITTED-IN NFC CHIP

1510116 · · · CMS ADF 32 BW · · · E 18M.16

· Tubular sports cuff, knitted to shape using goring technique
· Artwork made with Stoll-ikat plating®
· Abrasion protection element in Intarsia technique
· Integrated opening for smart watch on left cuff
· NFC chip knitted into right cuff

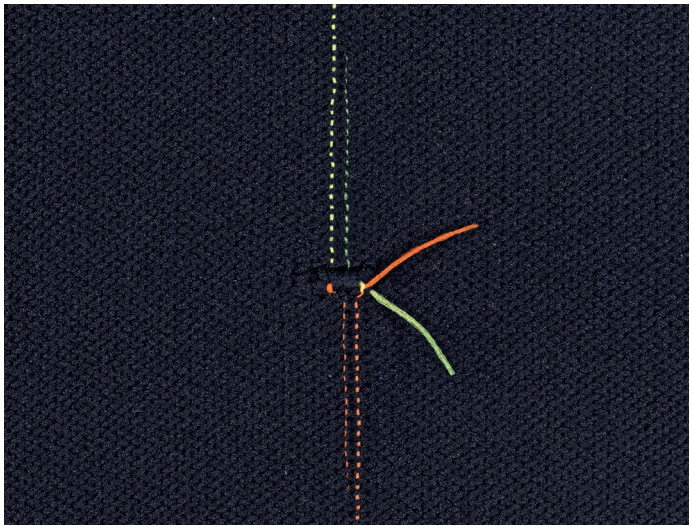

WATCH PROTECTION ELEMENT

APPLIED KNITTING TECHNOLOGY FOR PERFORMANCE+ KNITS



Connecting two or more conductive wires by Selective Plating

· Applicable for horizontal and vertical conductive wires



Connecting two or more conductive wires by Selective Plating

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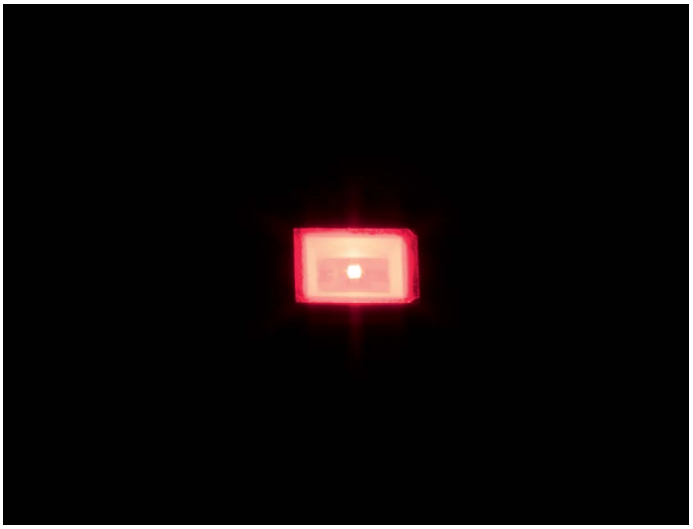


LED integration into knitted pocket

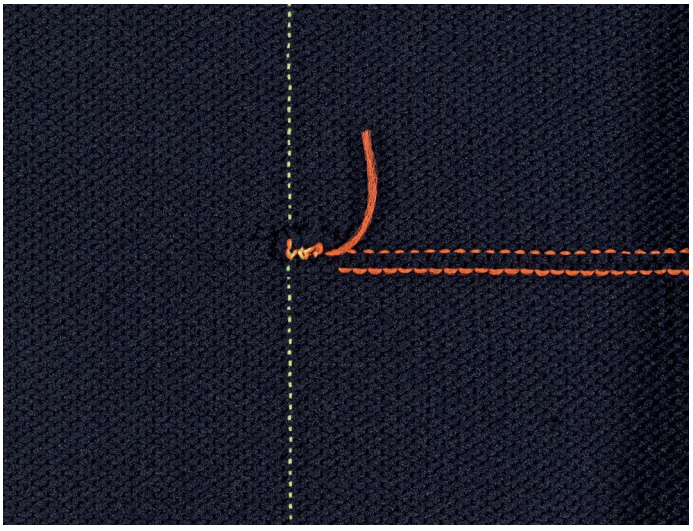
· Connection of poles by plated connective yarn

Shield-off single crossing conductive wires

· Selective Plating in horizontal direction

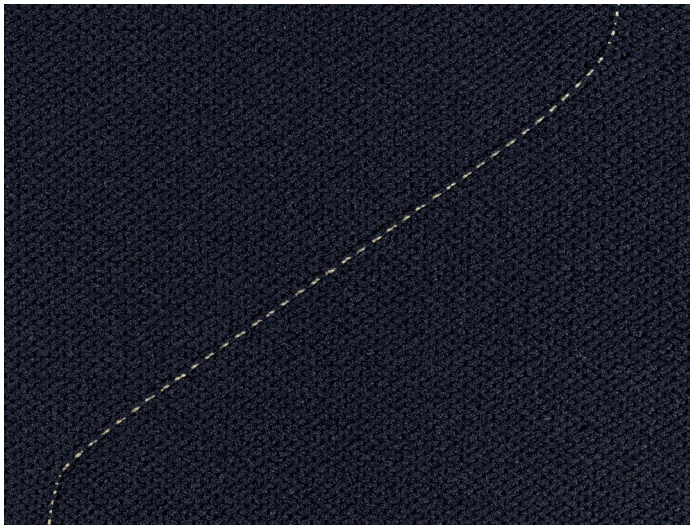
· Vertical insertion of conductive wire in-between plating feeders

STOLL knitting technologists were briefed to invent fabrics, which incorporate electric circuits for various purposes such as textile switches, textile sockets, vertical- and horizontal wire inserts. The scope was to make the circuits as invisible as possible on the outer shell of the fabric. The smart inventions below are generated with the latest CMS ADF technology and its unmatched plating features.



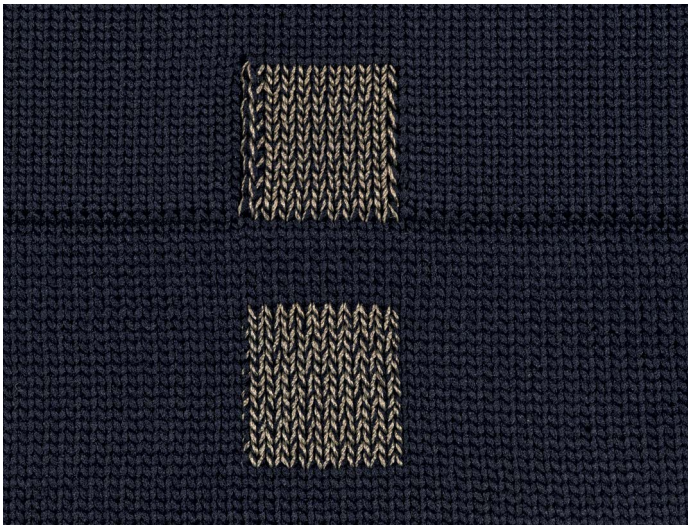
Connecting two or more conductive wires by Selective Plating

· Applicable for horizontal and vertical conductive wires



Inserting of conductive wire

· Applicable in diagonal direction in-between plating feeders



Textile switch: selective plated sections can be overlapped to close the circuit

Textile socket in tubular and Selective Plating technique

· Plus and minus poles are plated on separate layers within the pocket, remaining isolated from each other

1610004 · · · CMS ADF 32 BW · · · E 18M.16

- Fully Fashion sports top, knitted in one piece
- Pre-shaped cups created using 3D goring technology and variable stitch density
- Double layer construction technique, with different purl stitches and net structures
- Body mapping using Stoll-ikat plating® and various rib structures
- Grin through of back layer, for a 3D look
- Knitted-on pocket for removable NFC chip


KNITTED-IN MESH STRUCTURES, FOR IMPROVED MOISTURE TRANSFER
ERGONOMICAL SEAMS IN CENTRE BACK, FOR EXTRA COMFORT

NFC TECHNOLOGY

A conversation between
Marc Höntsch, Vice President SMARTRAC
and **Jörg Hartmann, STOLL**

What is the reason for SMARTRAC's success?
SMARTRAC has established itself as the world's leading RFID company – in terms of innovation, quality, variety and the sheer quantity of passive RFID inlays and tags. RFID technology is probably the only economically feasible way to connect and digitize trillions of "simple things". Equipped with RFID (including NFC and RAIN UHF) tags, each "thing" can provide data about its condition, location, state or usage. So as a key technology, RFID truly provides item-level visibility for all kinds of goods and parts, at very modest costs. In retail and fashion, SMARTRAC is what makes schemes like inventory accuracy, loss prevention, authentication, customer experience, brand activation or omni-channel readiness possible.

What are the main uses for NFC technology in particular?
As a subset of RFID technology, NFC makes life very convenient for consumers around the world – simplifying transactions, swapping digital content and connecting electronic devices, with a simple touch. A standards-based connectivity technology that's already available in countless smartphones, NFC brings together today's diverse contactless technologies, enabling current and future solutions in everything from access control,

Adhesive NFC Tags

consumer electronics, fashion and healthcare, to information collection and exchange, loyalty and coupons, payments, retail, transport and wearables.

What excites you about knitting technology?

It is very exciting to see the many developments in the knitting industry, especially in recent years. Increasingly demanding consumers are driving the creativity of designers, yarn manufacturers – and, of course, knitters – to develop even more specialized products for global markets. The latest achievements, such as running shoes that track athletic activities, smart garments or touch-sensitive cuffs, are only a few examples of the ongoing digitization of fashion. RFID technology will play a key role in this area, and SMARTRAC is the right partner to help shape the future.

What opportunities do you see for your technology in textiles?

NFC technology is supported by the world's leading communication device manufacturers, semiconductor producers, network operators, IT and services companies – so it is already widely available to consumers around the globe. On the other hand, the fashion and retail industries are looking for solutions to provide product innovations, fresh designs, enhanced consumer experience or omni-channel integration. By making textiles and merchandise smart, with embedded NFC or RAIN UHF tags, our RFID-based solutions can meet this demand, making it possible to produce next-generation textiles that can drive customers' brand loyalty and increase retailers' margins.

What impact will this technology have on our society in the future?

We see a clear trend towards digitization across all spheres of life. It's all about communication and the rising demand of brands and consumers for innovative solutions. Textiles and fashion are very important parts of life, and therefore play a key role in that transition. It's no coincidence that wearables are all the rage. My impression is that designers in particular face exciting times, since they can be even more creative by working with a broad array of new garments while integrating technologies like LEDs, sensors, eye-tracking, electrical circuits - and of course RFID.

Marc Höntsch, Vice President, Business Development Retail/ Merchandise Visibility at SMARTRAC

ABOUT

SMARTRAC is the global leader in RFID and NFC technology, with a broad portfolio of products and solutions that are ready for the Internet of Things (IoT). Put simply, SMARTRAC makes products smart – giving businesses the power to identify, authenticate, track and complement their own products and services.
The company's products are used in a wide variety of different ways: access control, animal ID, automated fare collection, automotive, border control, contactless payment, electronic product ID, library and media management, laundry, logistics, public transport, retail, supply-chain management and much more. Drawing on its global research and development, production and sales network, SMARTRAC combines physical products with its IoT platform SMART COSMOS, empowering the ecosystem of connected things. SMARTRAC was founded in 2000, with headquarters in Amsterdam.

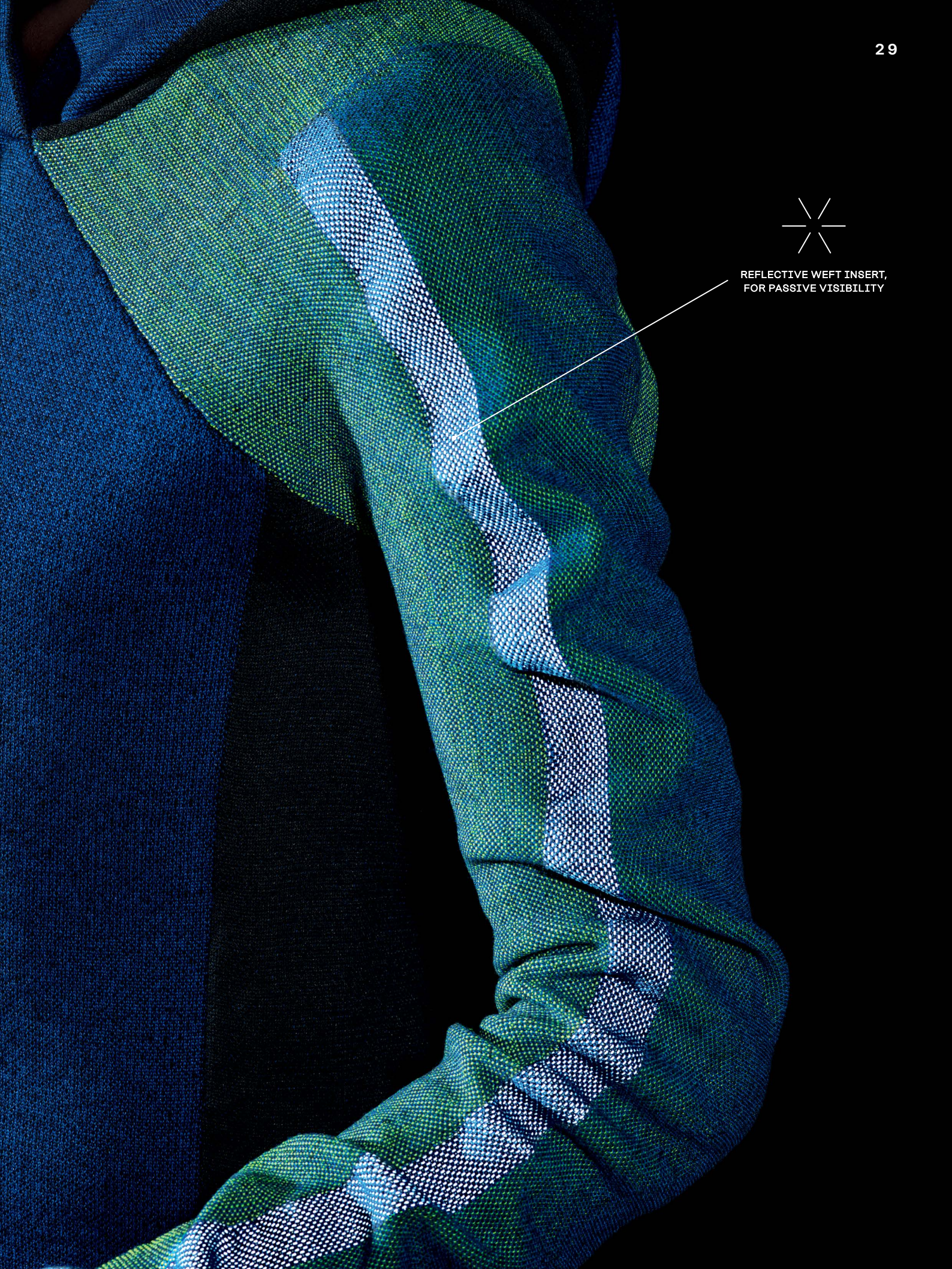

REFLECTIVE WEFT INSERT,
FOR PASSIVE VISIBILITY

1610016 · · · CMS ADF 32 BW · · · E 18M.16

- Fully Fashion hoody
- Sleeves knitted using elastic Stoll-weave-in® structure
- Pre-shaping on sleeve and hood created with Stoll-weave-in® technique
- Front and back panel knitted in plated interlock structure
- Hood features Intarsia Plating
- Side panel in plated float jacquard structure to enhance temperature balance, featuring a knitted-in NFC chip

1610016 · · · CMS ADF 32 BW · · · E 18M.16

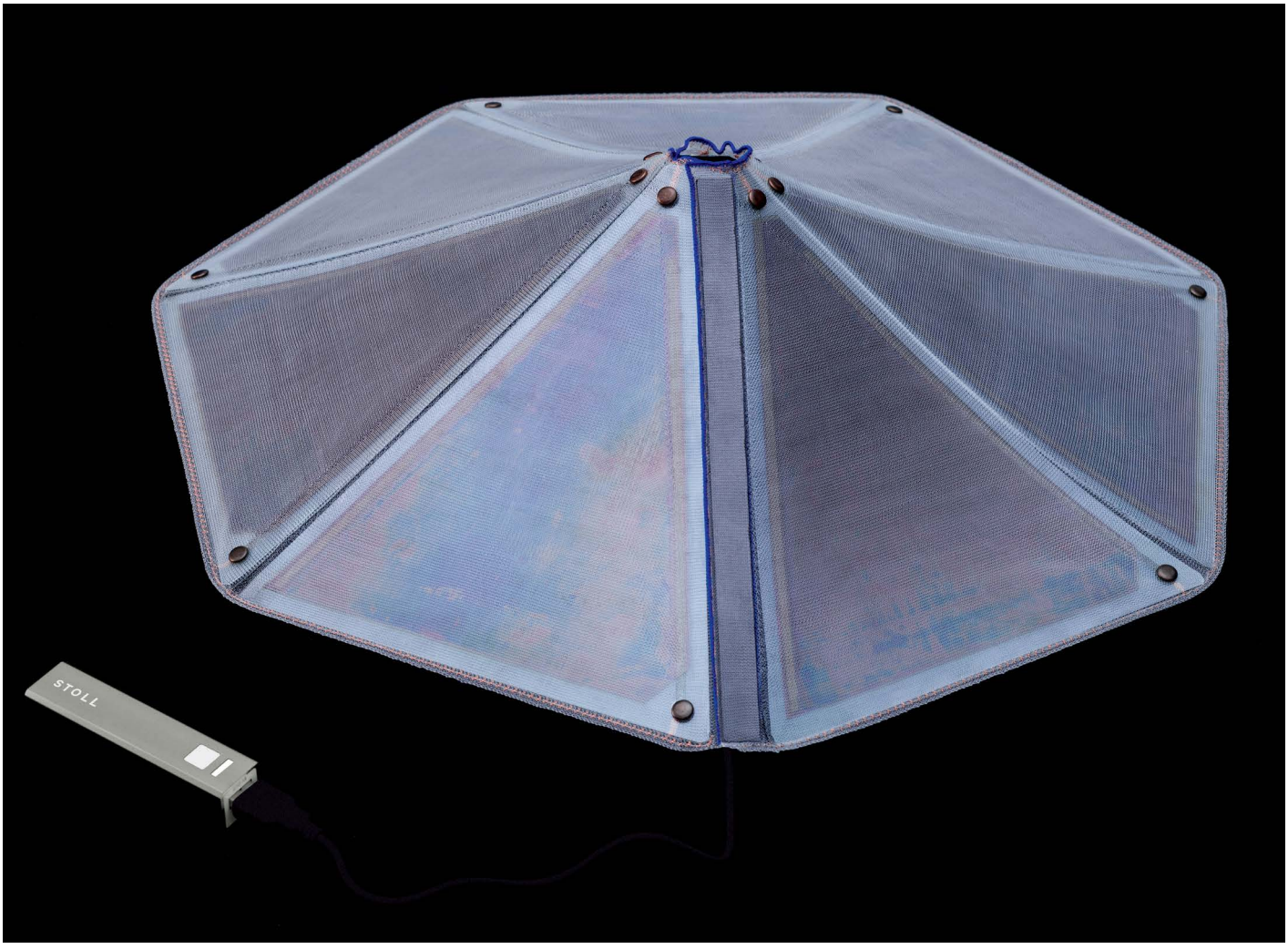
· Fully Fashion hoody
· Sleeves knitted-in using Stoll-weave-in structure
· Pre-shaping on sleeve and hood
· Front and back piece knitted-in plated interlock structure
· Hood features intarsia plating
· NFC chip knitted-in to side panel


REFLECTIVE WEFT INSERT,
FOR PASSIVE VISIBILITY

ORGANIC PHOTOVOLTAICS

A conversation between
Dr. Hans-Joachim Egelhaaf, ZAE
and **Jörg Hartmann, STOLL**

Printer of photovoltaic modules



Portable solar charger (1610015) for outdoors with knitted-in photovoltaic modules – see next page for details

What excites you about organic photovoltaics?

Organic photovoltaics is a revolutionary technology which makes it possible to supply power where other conventional technologies simply can't. The main advantages of these printed solar modules are their light weight, semi-transparency, the possibility to use flexible or any other types of substrates, and the possibility to produce power even under low light conditions. On top of this, they also offer freedom in design, colour and shape. Our motivation was born from the enormous progress which has been made in this cutting-edge technology, and the potential for it to be widely accepted and commonly used in the nearest future.

What are the main uses for this technology?

The biggest market for OPV is currently in buildings, where windows and façades can be equipped with translucent or opaque solar modules. In Germany alone, an estimated 200 – 600 km² of usable façade area is currently under discussion, where PV technology could be easily built in. The growing demand for decentralized power generation reinforces the importance and rapid growth of this market. At the same time, the potential for wearable and consumer electronic applications is very high and only expected to grow. Nowadays, the demand for lightweight solar chargers is almost infinite.

What potential do you see for using organic photovoltaics in textiles?

We see great opportunities in textiles, where OPV can really show its full potential compared to other PV technologies, like its flexibility and low weight. On top of this, OPV modules can easily be integrated into textiles by any industrially established method, like sewing or riveting. To have your own power supply for your electronics with you at any time, integrated into your jacket or bag, is high on many consumers' wish lists, to say the least.

What are your thoughts on our mutual portable solar charger project?

A personal light weight portable solar charger, which you can fold and unfold anywhere and fits in any bag, is the ideal outdoor tool for many customers. The aesthetically appealing solar module generates power, which is then stored in a power bank that you can use to charge a mobile phone. Using conductive thin threads makes it possible to connect the solar modules almost invisibly, for a clean look.

What role will photovoltaics play in our future?

The German Government's goal is to produce 80 % of all the consumed energy in the country from renewable energy sources by 2050. This can be only achieved with the help of photovoltaics. The OPV will play a major role in the overall energy mix of power production. It will fill the niche where no conventional PV can be built in – façades, roofs with low payloads, walls and inside windows, for example.

Dr. Hans-Joachim Egelhaaf
Head of the Group – Solar Factory of the Future

ABOUT

The Bavarian Center for Applied Energy Research (ZAE Bayern) is a registered non-profit association, which was set up to promote energy research, education, consultation, information, and documentation in all fields relating to energy research. The association supports a scientific research institute with divisions in Würzburg, Garching, Erlangen, Nuremberg and Hof, employing more than 200 scientists, technicians, administrative staff and students. Since it was founded in 1991, the ZAE has become a nationally and internationally recognized research institute.

In the 'Solar Factory of the Future', printed solar modules are developed which can produce energy for less than 5 €ct/kWh, based on large scale printing techniques for both organic and inorganic solar modules. To make optimized modules on a scale of several hundred kWp/year, the lab is equipped with a new multi-head machine. This 12m long roll-to-roll printing machine enables a full inline process (including encapsulation) in a single sequence. Besides large area processing, a core competence of the Solar Factory is the processing of solar modules, through inkjet printing. This technique allows high precision processing in a non-contact printing process, with low waste of ink. On top of this, the method is also roll-to-roll compatible and allows for complete design freedom. This paves the way for the digital printing of photovoltaic (PV) modules.

PRINTED ORGANIC PHOTOVOLTAIC MODULE, INLAID IN TUBULAR KNIT

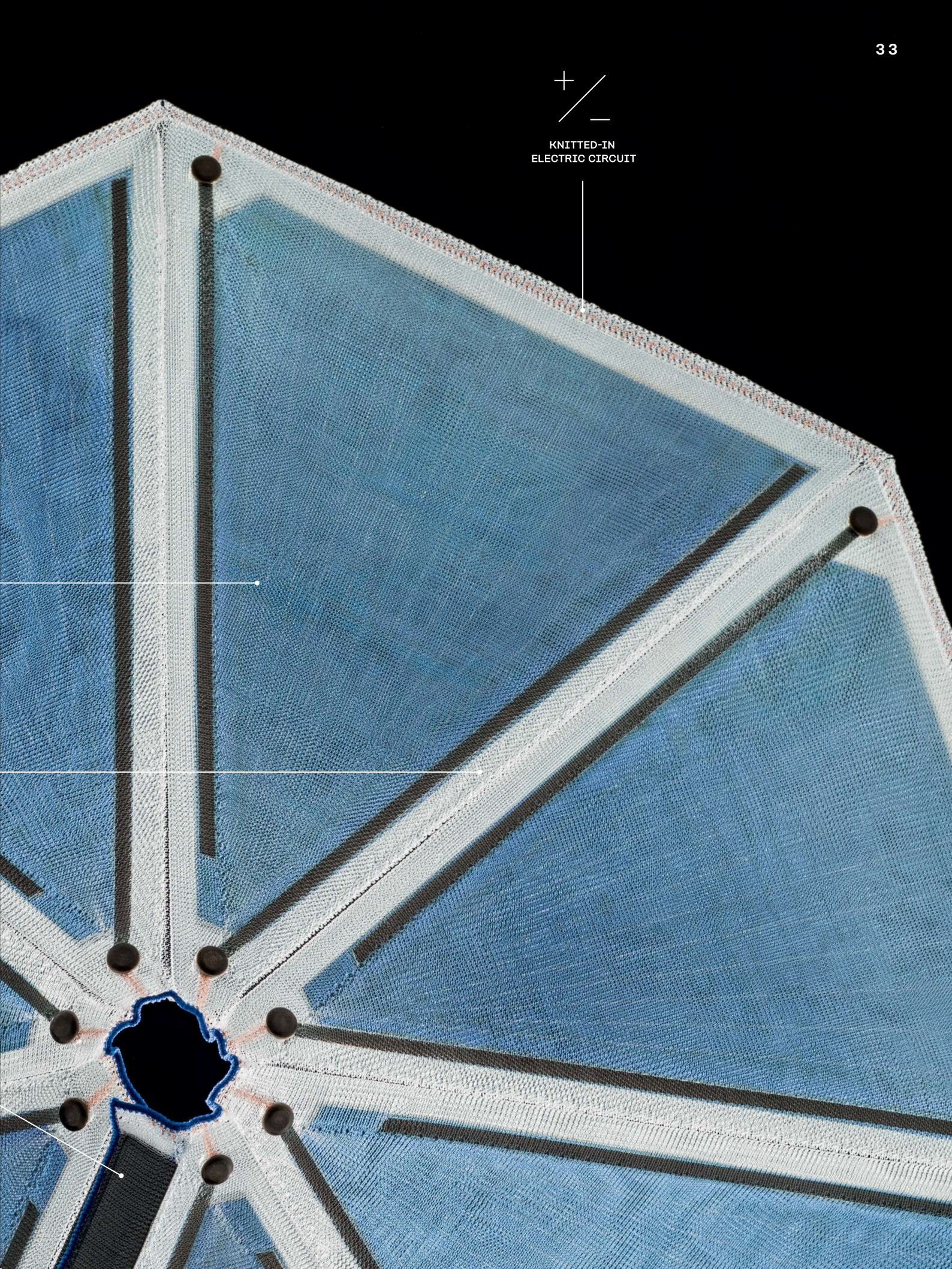
FOLDABLE TO ONE MODULE SIZE

MAGNETIC CLOSURE

1610015 · · · CMS ADF 32 BW · · · E 18M.16

· Portable solar charger for outdoors created using goring technique
· Integrated electric circuit achieved by plating and tucking conductive yarns
· Modules are riveted, for connectivity

Explore the features at: nfc.stoll.com/video/stoll_performance_plus.mp4


KNITTED-IN
ELECTRIC CIRCUIT

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