



Nighthawk™ adhesive patch enhances patient experience

Case study: Partnership, DuPont materials enable concept patch for long-term medical wearables



Patient with applied smart patch

Project

Innovative technologies for wearable medical devices are highly valued because of the huge market growth potential for such devices and the need to improve the performance of these devices to positively impact patient comfort and compliance.

With proven expertise and advanced materials technologies for skin contact devices, DuPont Healthcare has collaborated with TNO Holst Centre and Pronat Medical to develop a new wearable medical adhesive concept patch for monitoring, diagnostics and/or treatment.

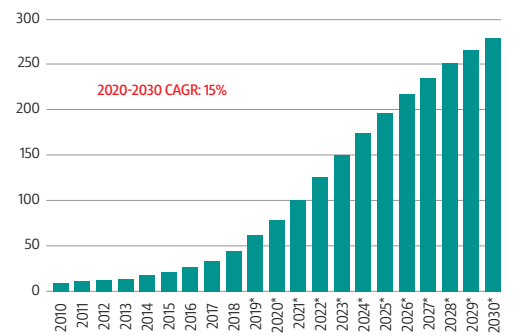
The Nighthawk™ adhesive concept patch is especially designed to improve wearability and long-term comfort, enhancing the patient experience while reliably recording electrical signals for vital signs and physiological parameters. DuPont™ Liveo™ silicone technologies and DuPont™ Intexar™ conductive inks are key design materials for this smart patch concept. The concept illustrates how the power of design and technology can help to address human factor challenges.

Challenges

Market dynamics

Wearable medical devices have substantial market value, growth potential and application opportunities in the increasingly connected healthcare industry.

2010-2030 skin patch market (in millions of units)



Source: IDTechEx Skin Patch Market Report. | Data predates COVID-19 pandemic. | * = Projected.

Megatrends driving wearables growth include population growth and aging; chronic disease incidence rates; health and fitness interest; overburdened healthcare systems; and industry priorities to improve care quality, accessibility and cost control. Wearable devices are increasingly used for outpatient monitoring, especially as COVID-19 virus precautions accelerate the trend to limit hospital stays, control costs and optimize healthcare resources.



Two of the largest market segments for medical wearables are diabetes management devices and cardiac monitoring devices. Breakthroughs in diabetes include continuous glucose monitoring and the automatic supply of needed insulin from a wireless insulin pump. For cardiac care, wearable monitoring devices and mobile telemetry can help track patients' electrocardiogram (ECG or EKG) or temperature data and trigger emergency intervention if required. In addition to these two priority applications, new medical/healthcare patch solutions are being explored for use in drug delivery devices, as well as for monitoring and diagnosis of a wide range of diseases such as COPD and COVID-19.

Design needs

The ability to effectively monitor an individual's health conditions – with electrical body signals, for example – and then deliver clinical-grade data for analysis without delay is revolutionizing healthcare. To support fast market adoption of wearables at the OEM and patient levels, several design challenges must be overcome.

One challenge is to achieve long-term, accurate monitoring of biosignals with a device attached for a few days – or up to as many as 14 days. Current available technology is limited by the battery lifetime; the electrode performance; and the device wearability on skin when exposed to sweat, humidity and bathing water. Also, skin contact patches potentially will need to adapt to several skin types, based on age, gender and culture, and will require versatile patch adhesives.

Another significant design challenge is to improve the patient experience with a device patch that is easily applied, comfortable and nonirritating; stays fixed in place for days during regular living activities; and can be removed painlessly without causing trauma at the end of the procedure. The patch needs to allow typical body movements without impacting the signal quality or the reliability of the patch's adhesion to the skin. If the skin becomes irritated after a short period, this typically will disallow attaching another device in the irritated area, create patient discomfort and jeopardize patient compliance.



Nighthawk™ adhesive concept patch

Solution

Advanced materials

The smart adhesive patch concept for next-generation wearables relies on advanced materials that are being developed to provide improved electrode life, more data stability, better moisture control and increased patient comfort. DuPont™ Liveo™ medical-grade silicone adhesives provide good skin fixation without creating removal trauma, itchiness, sensitivity or other irritation. Silicone elastomers, when extruded in films, offer tunable wearability and excellent conformability, as well as stretchability, comfort and biocompatibility. Ergonomically, a smart patch should be so comfortable that the patient can forget they are wearing it in normal everyday life.

In addition to the Liveo™ silicones, DuPont™ Intexar™ stretchable technologies – silver- and carbon-based electrically conductive inks and thermoplastic polyurethane (TPU) films – also are used for signal transfer in medical device smart patches, as well as for smart, stretchable sports and fitness clothing.

Concept patch advantages

The Nighthawk™ smart adhesive concept patch, developed in collaboration with TNO Holst Centre (R&D electronics) and Pronat Medical (ergonomics), provides a breathable, cushioning skin interface; dielectric insulation to protect signal quality; long-term wear with secure, skin-friendly, silicone-based adhesion; comfort and conformability with stretchable materials; and secure connections for biosignal reliability.

The patch maintains a minimum distance between sensing electrodes for data stability and accuracy. Also, the liner system is defined for effectively attaching the patch to the body without losing control of the pliable design. The 20% stretchability of the shape is unmatched by any other design on the market, as are other patient-centric attributes of the Nighthawk™ concept patch.

Key benefits provided by DuPont's medical portfolio include:

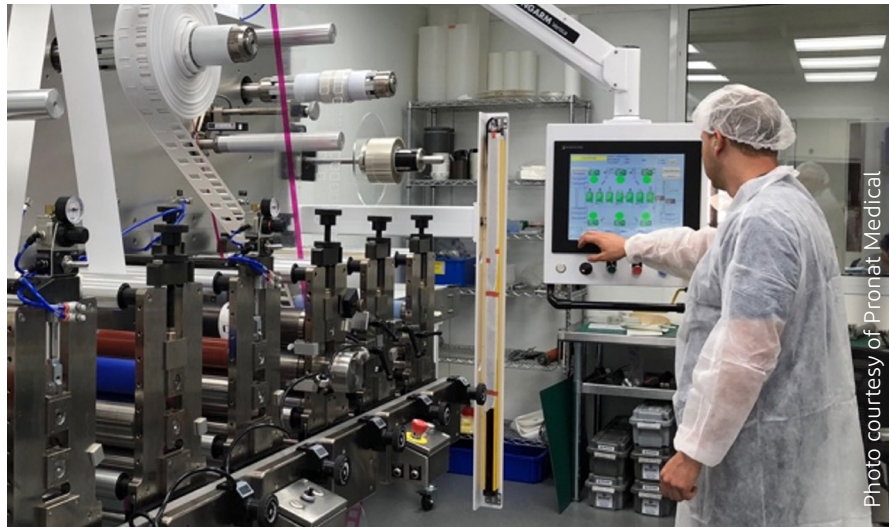
- **Protection** with a gentle, breathable, cushioning skin interface
- **Insulation** with inherent silicone dielectric properties to help secure wearables from foreign materials and external signals and avoid shortcuts and crosstalk to achieve optimal signal quality
- **Stable wear** with flexible, soft silicone films that ensure secure, skin-friendly adhesion
- **Comfort and compliance** with biocompatible, flexible, stretchable materials
- **Connection and conductivity** with conductive inks for biosignal reliability



Smart collaboration

The collaborative development process for the Nighthawk™ concept patch has involved three partners working closely together with complementary skills and strengths. This cooperative partnership transformed an idea into an actual prototype within just one year. The team shortened the timeline thanks to an effective, iterative concept design and development process between the partners and the rapid implementation of advances.

TNO Holst Centre in the Netherlands specializes in evaluating and integrating wireless sensor technologies and flexible electronics for the new wearables patch design. Pronat Medical in Israel is an expert in material layer converting and the manufacture of complex, flexible patches. And DuPont brings in-depth capabilities in applications engineering and materials research and development, as well as expertise in meeting challenges for skin contact applications with silicone-based technologies.



Delta reel-to-reel production line at Pronat Medical

TNO Holst Centre: Electronics expertise

TNO Holst Centre is focused on the functionality of the wearable device electronic system. In addition, in cases of smart clothing, the center also offers a dedicated fashion designer who strives to make the wearable patch appealing without becoming bulky or affecting clothing aesthetics.

“For the wearable adhesive patch, we establish clinical partnerships to ensure proper testing protocols for specific device applications. We also conduct volunteer studies,” said Thiru Kanagasabapathi, program manager for medical wearables at TNO Holst Centre. “We strive for the most reliable electronics possible to ensure failsafe wearable device performance.”

Learn more about TNO Holst Centre at holstcentre.com.

Pronat Medical: Assembly expertise

Working as an interface between DuPont and TNO Holst Centre, Pronat Medical oversees manufacturability aspects of the adhesive patch and the assembly requirements to ensure high-level functionality and wearability. Under cleanroom conditions, die-cutting, lamination and assembly processes are repeated meticulously for each design iteration, following TNO Holst Centre’s feedback on tested performance.

“The way we introduce liners and supports is absolutely critical to and enables placing the patch on the body without losing control of a patch made from very pliable materials,” said Paul Rosenstein, vice president of Pronat Medical. “The human factor or ergonomic engineering is normally best solved using our many years of experience helping our customers bring complex assemblies to market.”

Learn more about Pronat Medical at pronatmedical.com.

DuPont: Materials science

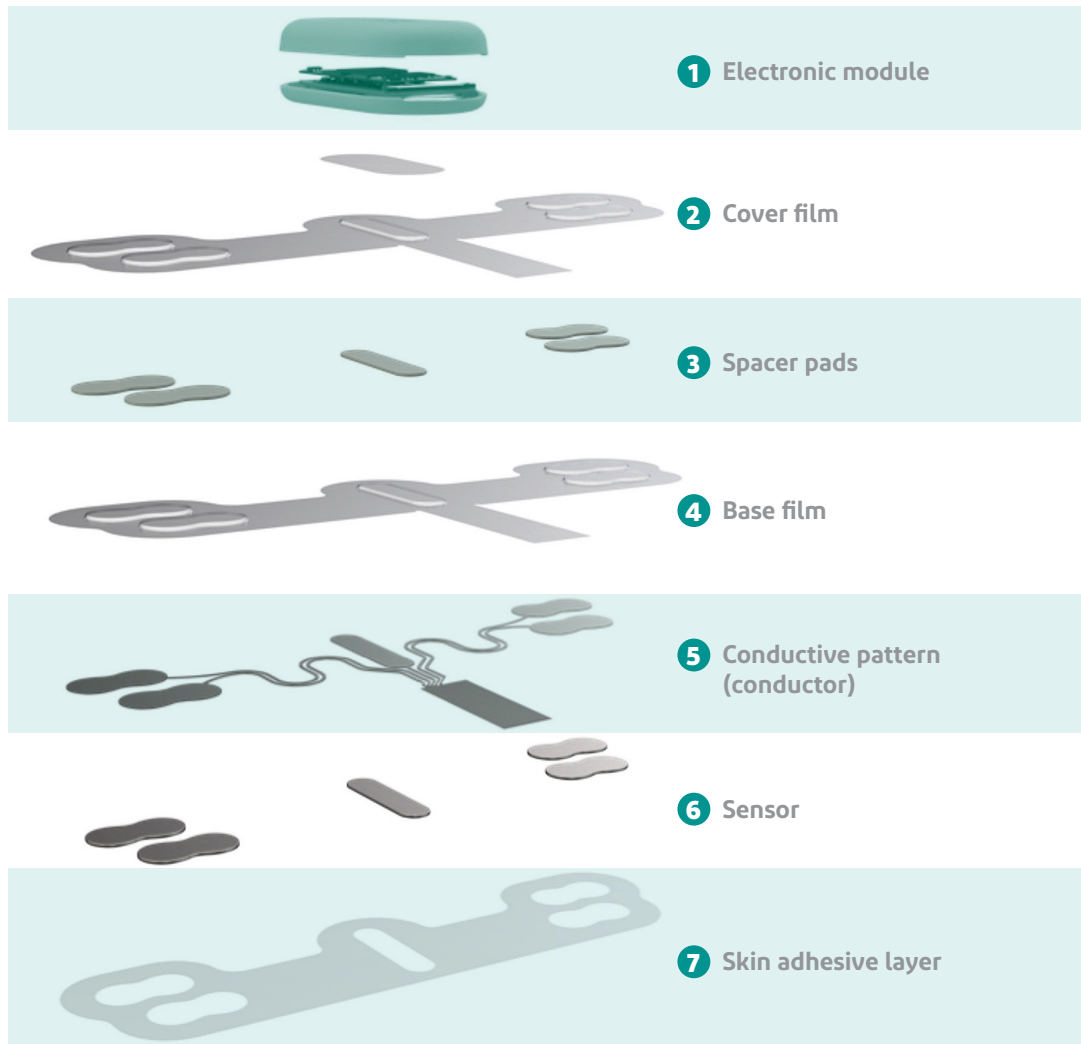
The expertise of the Nighthawk™ patch development partners complemented DuPont’s expertise in healthcare applied science and applications engineering. The full range and capabilities of DuPont™ Liveo™ silicones and DuPont™ Intexar™ conductive inks factored into the patch design.

“As the industry transitions from a model focused on treating health conditions to a proactive, well-care approach enabling patient monitoring, diagnostics and care delivery in inpatient and outpatient settings, DuPont continues to leverage its materials and technical and regulatory resources and to develop partnerships across the global medical value chain to drive the development of next-generation technologies,” said Jennifer Gemo, global strategic marketing leader for DuPont Healthcare. “DuPont is committed to advancing the development of new wearables and self-care devices for better patient outcomes.”

Learn more about Liveo™ at liveo.dupont.com and Intexar™ at intexar.dupont.com.



Design overview



1 Electronic module: Electrical biosignals are read and transmitted by battery-powered, Bluetooth®-enabled monitoring devices that can be protected with silicone encapsulants.

2 4 Base and cover films: Insulating medical-grade silicone elastomers can be extruded in films to protect and support the assembly with stretchability and conformability integrated into smart medical adhesive patches.

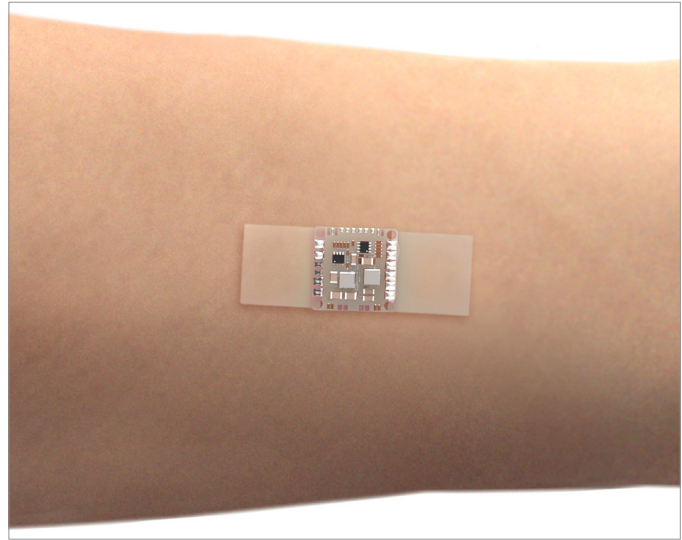
3 Spacer pads: Silicone elastomer solutions enhance electrical insulation and connection reliability and smart patch comfort.

6 Sensor technology: Signal sensing relies on dry electrodes for skin contact to ensure stable and reliable recording of accurate biosignals when integrated into adhesive skin patches.

7 Skin adhesive layer: Medical-grade silicone soft-skin adhesives and pressure-sensitive adhesives help to secure long-lasting, skin-friendly wearable device attachment.

Looking ahead

As healthcare shifts from treatment and cure to disease prevention with smart solutions, DuPont technologies will drive more wearables innovation. Our legendary expertise, transformational science, and connected solutions with DuPont™ Liveo™ silicones and DuPont™ Intexar™ conductive inks contribute to smarter healthcare and positive patient outcomes.



To learn more about DuPont's healthcare solutions, visit: healthcare.dupont.com



Smarter Healthcare.
Positive Patient Outcomes.

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