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"Epidermal Electronics" Printed On The Membrane AS Tattoo

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Abstract:
In modern advancement of electronics world leads the research community towards the printed version of all the devices, which is known as flexible electronics. In this paper we will describe the way to "print" devices directly onto the skin so people can wear them for an extended period while performing normal daily activities. Such systems could be used to track health and monitor healing near the skin's surface, as in the case of surgical wounds.

Key words: *flexible & epidermal electronics, elastomer, MC10*

1.Introduction

The electronic systems that achieve thickness, effective elastic moduli, bending stiffnesses and areal mass densities matched to the epidermis is known as "epidermal electronics".

Unlike traditional wafer-based technologies, laminating such devices onto skin leads to conformal contact and adequate adhesion based on van der Waals interaction alone, in a manner that is mechanically invisible to the user. We describe systems incorporating electrophysiological, temperature and strain sensors as well as transistors, light-emitting diodes, photo detectors, radio frequency inductors, capacitors, oscillators and rectifying diodes. Solar cells and wireless coils provide option for power supply. We used this type of technology to measure electrical activity produced by the heart, brain and skeletal muscles and show that the resulting data contain sufficient information for an unusal type of computer game controller.

In theory, they could attach to the skin and record and transmit electrophysiological measurements for medical purposes. These early versions of the technology, which were designed to be applied to a thin, soft elastomer backing. For this purpose we can use thermoplastic elastomer, generally known as TPE.

2.Thermoplastic Elastomers

Thermoplastic Elastomers are generally low modulus, flexible materials that can be stretched repeatedly to at least twice their original length at room temperature with an ability to return to their approximate original length when stress is released. The grandfather materials with this property are thermoset rubbers, but many families of injection-moldable thermoplastic elastomers (TPEs) are replacing traditional rubbers. In addition to use in their basic form, TPEs are widely used to modify the properties of rigid thermoplastics, usually improving impact strength. This is quite common for sheet goods and general molding compounds.

3.New TPE Entrants

- Reactor TPO's (R-TPO's)
- Polyolefin Plastomers (POP's)
- Polyolefin Elastomers (POE's)

The new POPs and POEs are essentially very low molecular weight, linear low density polyethylenes (VLMW-LLDPE). The results of advancements in polymerization catalyst technology, these materials were originally developed to improve flexible packaging film characteristics. Recently, these more flexible polyethylenes have seen use as low-cost rubber replacements for some non-demanding molded goods applications. These primarily include products that will not be exposed to extremes in temperatures, pressures, loads or stress environments. In molded goods, these new materials are being used where a more or less limited degree of flexibility or tactile feel is desired. Note that they are not true elastomers.

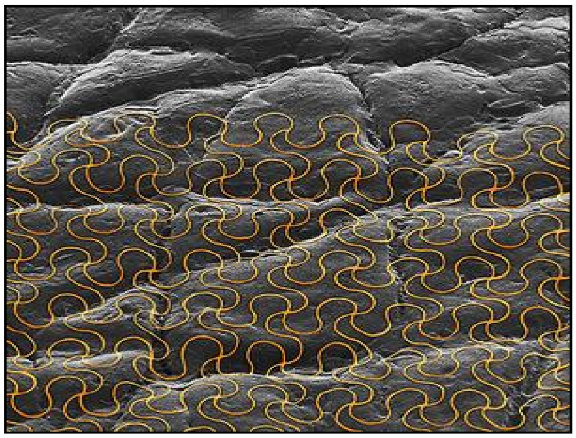

Figure 1

4. Electronic Tattoo

4.1.Electronic Tattoo

The image shows a colorized micrograph of an ultrathin mesh electronic system mounted on a skin replica.

Figuer 2

4.2.Skin Signals

This device, applied directly to the skin, can record useful medical information.

We can use a rubber stamp to just deliver the ultrathin mesh electronics directly to the surface of the skin. The researchers also found that they could use commercially available.

Eliminating the elastomer backing makes the device one-thirtieth as thick, and thus “more conformal to the kind of roughness that’s present naturally on the surface of the skin. It can be worn for up to two weeks before the skin’s natural exfoliation process causes it to flake off.

During the two weeks that it’s attached, the device can measure things like temperature, strain, and the hydration state of the skin, all of which are useful in tracking general health and wellness. One specific application could be to monitor wound healing: if a doctor or nurse attached the system near a surgical wound before the patient left the hospital, it could take measurements and transmit the information wirelessly to the health-care providers.

MC10, a startup in Cambridge, Massachusetts, is getting ready to commercialize high--performance electronics that can stretch. The technology could lead to such products as skin patches that monitor whether the wearer is sufficiently hydrated or inflatable balloon catheters equipped with sensors that measure electrical misfiring caused by cardiac arrhythmias.

Microelectronics has long depended on a rigid, brittle wafer, MC10’s CEO. MC10 uses a few tricks to change that. To make both the hydration-sensing patch and the catheter, gold electrodes and wires just a few hundred nanometers thick are deposited on silicon wafers by conventional means, then peeled off and applied to stretchable polymers. The serpentine wires elongate when the polymers stretch, either when the balloon inflates in the heart or as the patch moves around on the skin. The electrodes measure electrical impedance to detect the electrical signals in cardiac tissue or moisture levels in the skin.

Organic polymer electronics can only bend, not stretch, and they are slower than devices made of inorganic semiconductor materials or precious metals such as gold, so they can’t provide precise real-time biological readings.

MC10’s first product, expected to launch in late fall, will be a wearable device developed in a partnership with Reebok. The company is tight-lipped about the details. But in addition to its hydration patch, it is working on patches that use sensors to detect heartbeat, respiration, motion, temperature, blood oxygenation, and combinations of these indicators.

MC10’s skin patches can wirelessly transmit information to a nearby smart phone. A phone with a near-field communication chip can be waved over the patch, or the patch can be paired with a thin-film battery made by a commercial supplier, allowing continuous data transmission.

Next up will be balloon catheters that a cardiologist could snake through the heart to detect areas of misfiring cardiac tissue. Some of the prototypes in preclinical testing have dense arrays of electrodes that allow high-resolution mapping and ablation of that tissue. Further off are other medical devices, including implantable materials that conform to brain tissue, sensing seizures and stopping them.

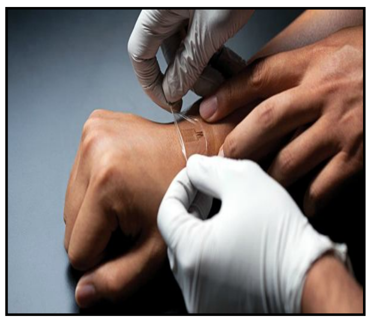

Figure 3: Scientists Print Electronic Sensors Directly onto the Skin

Figure 4

5.Future & Latest Development

In future we can graft a thin wire mesh onto the surface of the skin, allowing for the wireless transmission of health metrics, such as temperature and hydration, to central medical stations.

The device can stay attached to the skin for two weeks before the body's natural exfoliation process causes it to flake off. During those two weeks, however, the electronics can measure temperature, strain and hydration, all of which are general indicators of wellness. "One specific application could be to monitor wound healing: if a doctor or nurse attached the system near a surgical wound before the patient left the hospital, it could take measurements and transmit the information wirelessly to the health-care providers." Commercial application of the technology could be just a year and a half away.

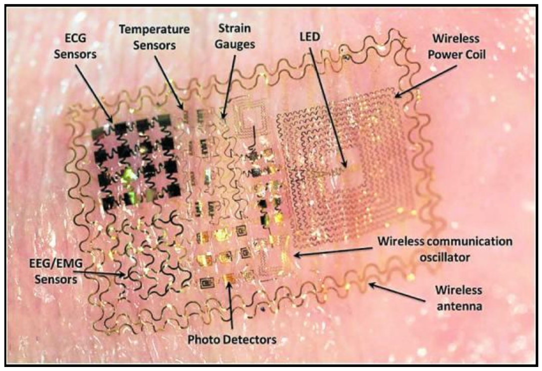

Figure 5: Electronic sensors printed on the skin

Taking advantage of recent advances in flexible electronics, researchers have devised a way to “print” the devices directly to the skin so that people can use them for a long period in the performance of daily activities.

This is still very much experimental, but devices can last on the skin for up to two weeks, and measure things like temperature, strain, the hydration state of skin, monitor wound healing. The sensors can communicate wirelessly with remote data gatherers. This is a way off from being commercially available, but it’s a lovely example of science fiction leading the way.

6.Conclusion

A new electronic skin patch, no more invasive than a temporary tattoo, marks a major breakthrough in human-machine interfaces. Tiny semiconductor circuits that stretch with the skin could be rubbed onto a person’s skin to monitor muscle activity, heart activity or even brain waves in real time without using bulky medical equipment.The epidermal electronic circuit is initially mounted on a super-thin sheet of soluble plastic and laminated onto the skin with water, just like a temporary tattoo. Once it’s on, it can bend, wrinkle and stretch along with a wearer’s skin — it doesn’t pop off or snap, which no small feat is considering this is a high-performance semiconductor. When it’s no longer needed, it peels off like a layer of sunburned skin.

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