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Epidermal Electronics Hold Promise for Patient Care

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By [Krystina Steffen](#), *staff writer* – September 7, 2011

Epidermal electronics are the latest devices with the potential to transform health care and the way we interact with technology. These ultrathin devices are applied to the skin like a temporary tattoo. No longer will individuals and medical professionals have to deal with cumbersome electrodes and gel, and possibly even needles. Materials scientist John Rogers from the University of Illinois at Urbana-Champaign has proven that these devices can successfully monitor the heart and brain, and can function by voice commands or movement.

“You can’t change the biology so you really have to redefine the nature of electronics,” said University of Illinois engineering professor John Rogers. [1]

The epidermal electronic devices are composed of carbon nanotubes and rubber elastomer, and are super flexible. All the circuitry parts, including transistors, semiconductors, and diodes, have been minimized. The circuitry is silicon-based and formed in a wavy structure called “filamentary serpentine” to create an electronic web. Because of this design, Rogers and his colleagues can create devices that monitor temperature, heart rate, electric signals from the brain and muscles, and many other features in a unique, non-invasive way.

“The most interesting part to me is that he [Rogers] manages to make the metal electrode, the semiconductor devices, extremely small and structured,” said Qibing Pei, a materials science and engineering professor at UCLA. [2] “The filamentary serpentine devices can also stretch up to 30 percent. It’s quite compatible with the skin.”

The device is as thick and elastic as the skin itself. Much like a Band-Aid, the device can stay on for days and weeks at a time. It stays on even with the natural tendencies of the skin to be pulled, squished, twisted, and poked. And it conforms to the body part it is applied to. The Rogers Research Group has achieved previous successes in engineering devices and systems that are inspired by biology and integrate with the human body and its surroundings. They are known for fabricating devices on the nano and molecular scale for electronics and

photonics. [3] Rogers' epidermal electronic system provides strong computing capabilities along with flexibility, whereas most predecessors only focused on one of these features.

"The skin represents one of the most natural places to integrate electronics," said Rogers. "As the largest organ in our body, and our primary sensory mode of interaction with the world, it plays a special role." [4]

This category of electronics holds great promise not only in critical care situations, but for individuals with special needs, neonatal care and premature babies, and in long-term care facilities. Many reports still show that there are pitfalls in the health care field even with the current amount of technology in place. Patient misdiagnoses, dosage errors, and miscommunication remain an ongoing concern, and medical malpractice in all its forms still affects individuals and their loved ones. Technologies that provide convenient ways for health care professionals to access a patient's medical history, prescriptions, and contraindications can help prevent serious injuries and wrongful deaths that occur. This is especially helpful as many hand-offs occur in hospital settings and numerous people are involved in a patient's care.

"The device will help fill the need for equipment that is more convenient and less stressful for patients, permitting easier and more reliable monitoring," said engineering professor Zhenqiang Ma, from the University of Wisconsin. [5]

Professor Ma has researched various types of electronic skin that have the capacity to revolutionize the medical field. Patients such as those with serious heart disease often need to monitor their heart for an extended period of time to be aware of any abnormal cardiac rhythms. Bulky electrodes and wiring, extended cables, and rashes from the device make monitoring inconvenient. The electrodes must be moved frequently and monitoring thus gets interrupted. Epidermal electronic systems are better, high-performing devices that allow medical professionals a "...simpler, more reliable, and uninterrupted" way to provide their patients with improved medical care. [6] These devices are "...proved to be viable and low-cost in this demonstration which will greatly facilitate the practical clinical use of the electronic skin." [7]

The future for epidermal electronics is even vaster. These devices could be used to emit heat to heal wounds, for remote physical therapy and prosthetic limbs, create human and machine interfaces for music players and cell phones, and assist in covert communications. [8] Currently, these devices are not available to the mass market. But extensive testing has been accomplished. Brain waves, muscle movement, and speech have been successfully measured. [9] When the device was placed on the chest, the measurements mimicked what an electrocardiogram would produce. Brain activity was reproduced similar to what an electroencephalogram (EEG) would show. Muscle tissue data much like an electromyogram (EMG) was created successfully. When an epidermal electronic device with a microphone was placed on the throat, words were recognized. For people with special needs, these devices could aid their disability and help them overcome daily tasks without the burden of clunky devices and expensive in-home care.

"There are a lot of advancements that can happen immediately if you take more sophisticated existing conventional devices and put them in this spider web layout," said Rogers. [10]

Rogers has tested his epidermal electronic device and it can last up to two weeks on the skin. Longer than that and the skin's natural regenerating qualities take over. He is currently researching external power sources for the device, which currently runs on electronic coils in the device. Solar cells could be added for power and antennas could transmit signals for data. Solar cells made of amorphous silicon or CIGS (copper, indium, gallium, and selenide) can be constructed in small sizes and create enough power in low light environments too. [11] Long term, Rogers feels epidermal electronic systems "...could provide an electronic link to the body's most subtle processes, including the movement of enzymes and antibodies, to track the path of disease. Ultimately, we think that [our] efforts can blur the distinction between electronics and biology." [12]

The promise of epidermal electronics will continue as these devices show high-quality results. As an intelligent e-skin, it has the potential to monitor our health, safeguard our well-being, and transform modern medicine.

Sources

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