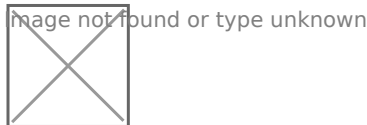


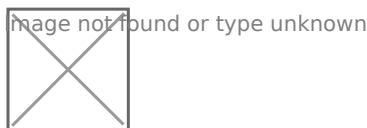
Electrochromic Resistive Pressure Sensor

Stanford researchers have developed a stretchable, low power consumption, highly tunable resistive pressure sensor and organic electrochromic device (ECD). This electronic skin detects and distinguishes varying pressure through real-time visible color change. The initial contact surface of the e-skin device is non-conducting, resulting in very low power consumption before applying pressure.



Electrochromic Resistive Pressure Sensor Schematic

Layers of silicone, single walled carbon nanotube electronic devices and electrochromic polymer make up the chameleon-inspired skin. Applying pressure can control the skin color, or skin color change can identify applied pressure.



Sequential images of a teddy bear demonstrate pressure variations via color changes.

The original color of the sensor changes from dark red to blue gray with a weak squeeze (applied pressure ~ 50 kPa) and reverts back to dark red upon release. The color changes to pale blue with a strong squeeze (applied pressure ~ 200 kPa).

This low power, electrochromic e-skin pressure sensor can be applied in areas such as robotics, prosthetics, healthcare, and hand held devices.

Related Technologies

[Stanford docket S14-024](#) **Skin-like, Wearable Pressure Sensor**

This wearable, flexible, high sensitivity pressure sensor provides information about cardiovascular health, emotional state, and other aspects of human physiology. Attached like a medical bandage, the ultra-thin sensor measures pulse waveforms over arteries or veins with high repeatability (> 3000 cycles).

[Stanford docket S14-211](#) **Self-Powered Electronic Skin**

Stanford's stretchable, energy harvesting electronic skin (e-skin) senses and distinguishes between normal pressure, tension, and bending. This human skin-like capability allows object manipulation, grasp control, and texture determination without needing external power.

NPR "All Tech Considered" Feature

["Just Like Human Skin, This Plastic Sheet Can Sense And Heal"](#), April 11, 2016

Applications

- **Touch sensors** with end user applications in:
 - Hand-held devices & touch screens
 - Image and motion stabilizers
 - Pinch pressure sensors
 - Robotics
 - Physiological / healthcare monitoring
 - Medical devices (like catheters) with sensitivity feedback
 - Prosthetics

Advantages

- Simple to Fabricate,
- Stretchable & Flexible
- Low Power Consumption

Publications

- Chou, Ho-Hsiu, Amanda Nguyen, Alex Chortos, John WF To, Chien Lu, Jianguo Mei, Tadanori Kurosawa, Won-Gyu Bae, Jeffrey B-H. Tok, and Zhenan Bao. "[A chameleon-inspired stretchable electronic skin with interactive colour changing](#)"

[controlled by tactile sensing.](#)" *Nature Communications* 6 (2015).

doi:10.1038/ncomms9011

- Tee, B.C.K., Chortos, A., Berndt, A., Nguyen, A.K., Tom, A., McGuire, A., Lin, Z.C., Tien, K., Bae, W.G., Wang, H. and Mei, P., 2015. [A skin-inspired organic digital mechanoreceptor](#). *Science*, 350(6258), pp.313-316.
- Tom Abate, "[Stanford engineers create artificial skin that can send pressure sensation to brain cell](#)," Stanford Report, October 15, 2015.

Patents

- Published Application: [20170031491](#)
- Published Application: [WO2017019887](#)
- Issued: [10,037,098 \(USA\)](#)

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