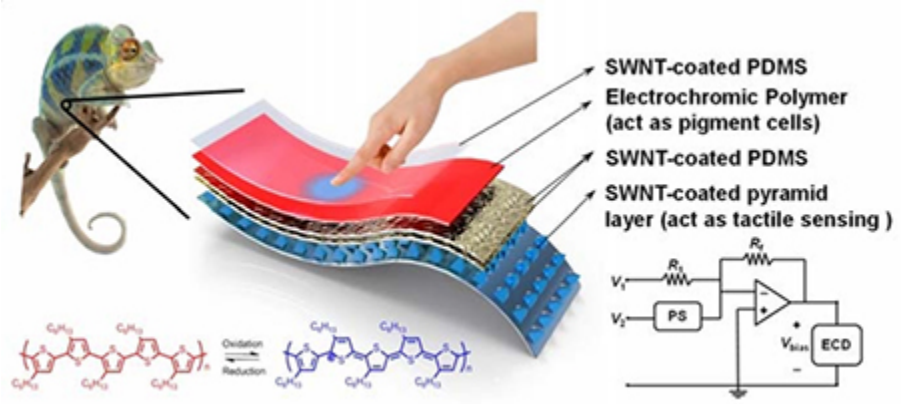
Docket #: S15-225

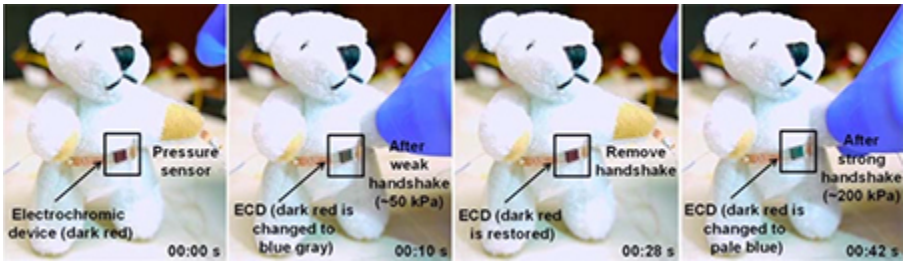
Electrochromic Resistive Pressure Sensor

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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