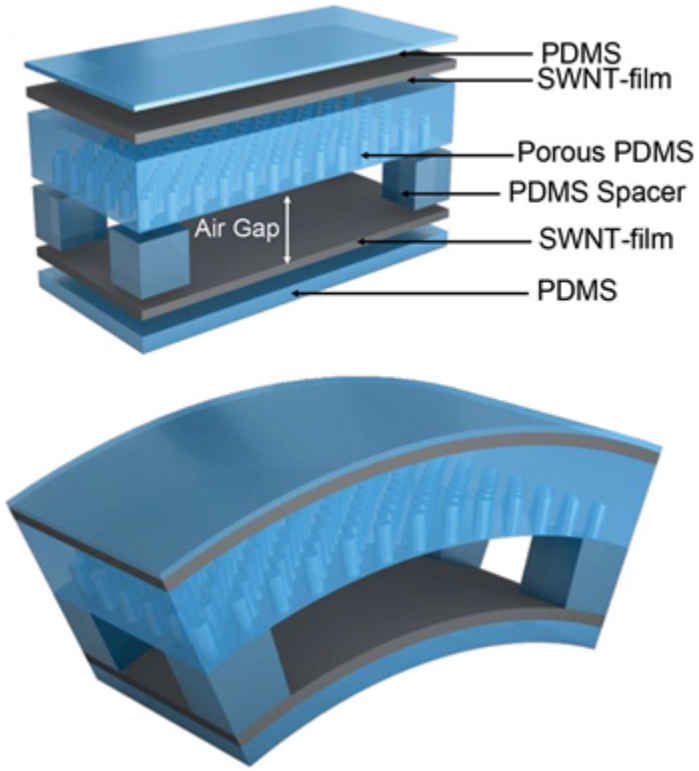
Docket #: S14-211

Self-Powered Electronic Skin

Stanford researchers have developed a stretchable, energy harvesting electronic skin (e-skin) that senses and distinguishes between normal pressure, tension, and bending. This human skin-like capability allows object manipulation, grasp control, and texture determination. The e-skin is comprised of layers of silicone and single walled carbon nanotube electronic devices.



Energy harvesting / self powered e-skin schematic of Polydimethylsiloxane (PDMS) and single walled carbon nanotube (SWNT) device film layers

The stretchable, capacitive design simultaneously measures the change in capacitance and film resistance, differentiates between normal pressure, strain and bending, and converts the mechanical stimuli to electricity. Future work will improve power generation and incorporate stretchable capacitors and battery into the

design.

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 15-225 **Electrochromic Resistive Pressure Sensor**
Stanford researchers have developed a stretchable, low power consumption, highly-tunable resistive pressure sensor and organic electrochromic device (ECDs). This electronic skin device detects applied pressure and distinguishes varying applied pressures through real-time visible color change.

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:
  - Robotics
  - Prosthetics
  - Hand-Held Devices & Touch Screens
  - Physiological / healthcare monitoring

Advantages

- Simple to Fabricate
- Stretchable & Flexible
- Versatile – distinguishes between various mechanical stimuli
- High Sensitivity – average of 0.7 kPa-1 and 1.5 kPa-1 in the pressure range 1 kappa, which is higher than previously reported stretchable capacitive pressure sensors

Publications

- Park, S., Kim, H., Vosgueritchian, M., Cheon, S., Kim, H., Koo, J. H., Kim, T. R., Lee, S., Schwartz, G., Chang, H. and Bao, Z. (2014), "Stretchable Energy-Harvesting Tactile Electronic Skin Capable of Differentiating Multiple Mechanical Stimuli Modes", *Advanced Materials* 26, no. 43 (2014): 7324-7332. doi: 10.1002/adma.201402574
- Santhanam, P., Fan, Shanhui "Suppressing non-radiative generation and recombination in LEDs, PVs, and photodiode detectors via inhomogeneous doping around the depletion region co-located with a heterojunction" *SPIE OPTO* (2021)

Patents

- Published Application: 20160033343
- Issued: 9,625,330 (USA)

Innovators

- Steve Park
- Zhenan Bao

Licensing Contact

Evan Elder

Senior Licensing Associate

Email