ETH zürich

Licensing Opportunity

Flexible tactile sensors for robotics and prosthetics with high sensitivity and spatial resolution

Fig. 1

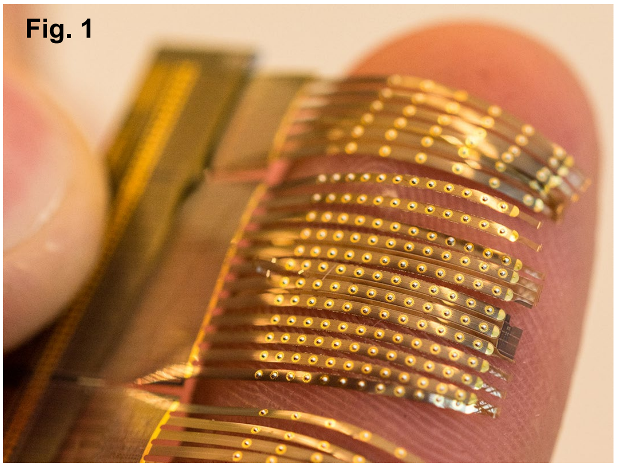
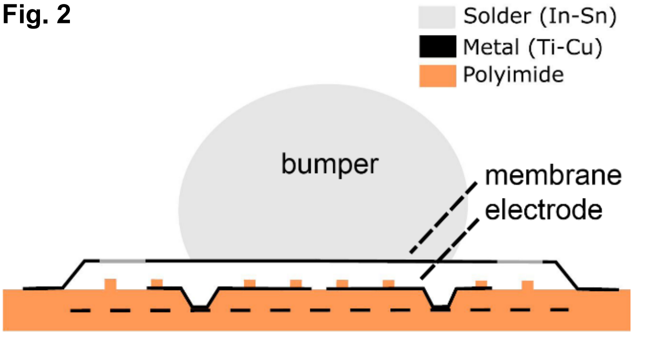


Fig. 2



Schematic view of a single sensor from an array. A force acting on the bumper changes the distance between membrane and electrode thus the capacitance which is measured electrically.

Application

Flexible electronic skin gives robots and prosthetic devices a sense of touch. It enables them to handle fragile or irregular objects with care and accuracy. The technology lets robots feel texture, detect slip, and sense gripping pressure. This opens new possibilities in automation, healthcare, manufacturing, and assistive technologies.

Features & Benefits

- Spatial resolution >100 sensors/cm^2
- Force range of sensor 1µN - 300 mN depending on the thickness of the covering skin layer
- Vibration sensing tested up to 1 kHz

Publications

- "Tactile Sensing With Scalable Capacitive Sensor Arrays on Flexible Substrates” (2021) https://doi.org/10.1109/JMEMS.2021.3104352
- "Artificial fingertip with embedded fibe-shaped sensing arrays for high resolution tactile sensing“ (2024) https://doi.org/10.1089/soro.2022.0238
- Patent pending: WO/2022/207552

transfer

ETH transfer
transfer@sl.ethz.ch
https://transfer.ethz.ch
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Invented by D-MAVT
J. Weichart, C. Roman, Ch. Hierold

Technology Readiness Level

1 2 3 **4** 5 6 7 8 9

Background

Humans feel and judge how hard to grip an object. Robots cannot. Existing touch sensors are often rigid and too coarse. They also struggle to fit curved or soft shapes, such as robotic fingers, grippers, or artificial limbs. This limits how safely and precisely machines can interact with their environment and adjust their movements in real time.

Invention

In this work redistribution layer (RDL) technology is exploited to build up a flexible sensor array (Fig.1). In RDL technology metal lines are deposited on electrically insolating films to relocate connectors to desired locations. In this way high density contact arrays are built. A post-process fabricates capacitive sensors directly on top of this substrate. The monolithic built solves the problem of electric integration. It eliminates soldering, which would introduce potential break points. A single sensor comprises a bumper on a suspended membrane (Fig. 2). Underneath the membrane is a metal electrode. When a force acts on the bumper, the membrane deflects and its distance to the underlying electrode changes, thus, a change in capacitance is detected.

An artificial fingertip was covered with a dense sensor network of 144 sensors. The distance between sensors was one millimeter. Robustness was successfully tested with a force of 15 N applied over 10’000 times.

Vibration sensing into the kHz range is feasible. Efforts are underway to speed up the downstream electronics, which are currently the bottleneck.

Interview with inventor: https://youtu.be/tOR1qThHm7o