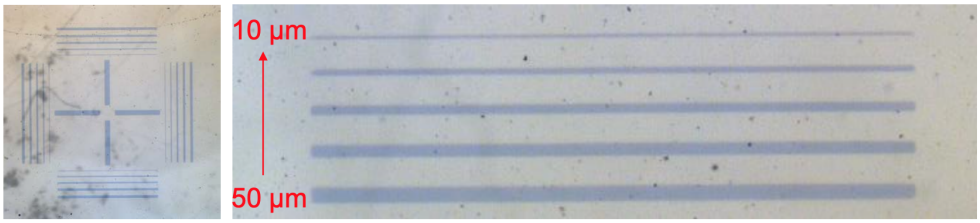
Docket #: S19-101

Directly photo-patternable, conductive, stretchable PEDOT:PSS

The Zhenan Bao Research Group at Stanford University developed and manufactured a photo-curable, directly patternable, stretchable, and highly conductive polymer that is ideal for bioelectronic applications, and stretchable electronic devices. PEDOT:PSS (Poly(3,4-ethylenedioxythiophene):poly(styrenesulfonate)) is the most widely used conductive polymer for wearables and implantable electronics, but device fabrication requires lengthy and tedious indirect patterning and dry etch processes. Bao's researchers use Poly(ethylene glycol) diacrylate (PEGDA) as the supplement to formulate a highly conductive, stretchable, and directly photo patternable PEDOT:PSS. They've successfully patterned (figure 1) and manufactured stretchable electronic devices (figure 2) using their material and manufacturing process.



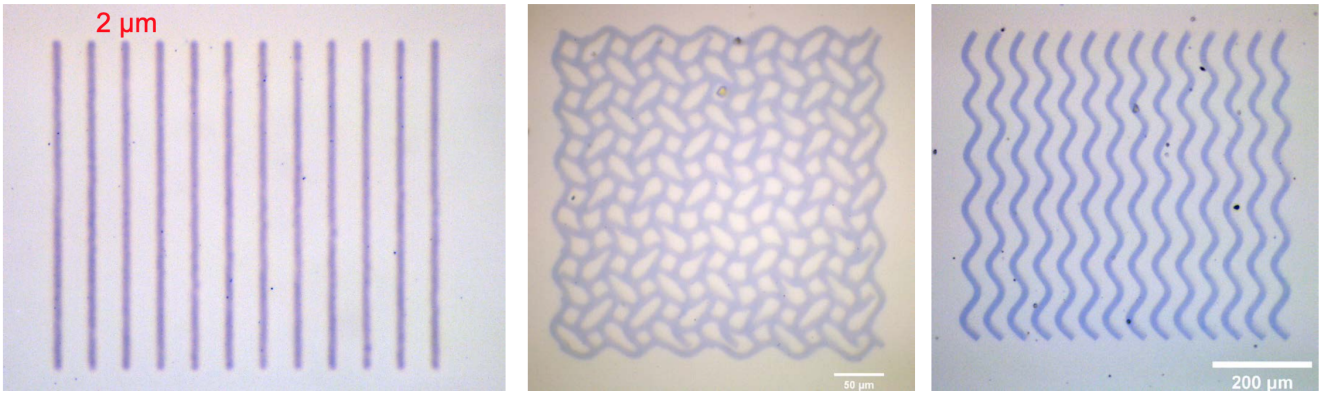


Figure 1 Photo patterned PEDOT showing possible minimal feature sizes with about 2 ?m minimum size.

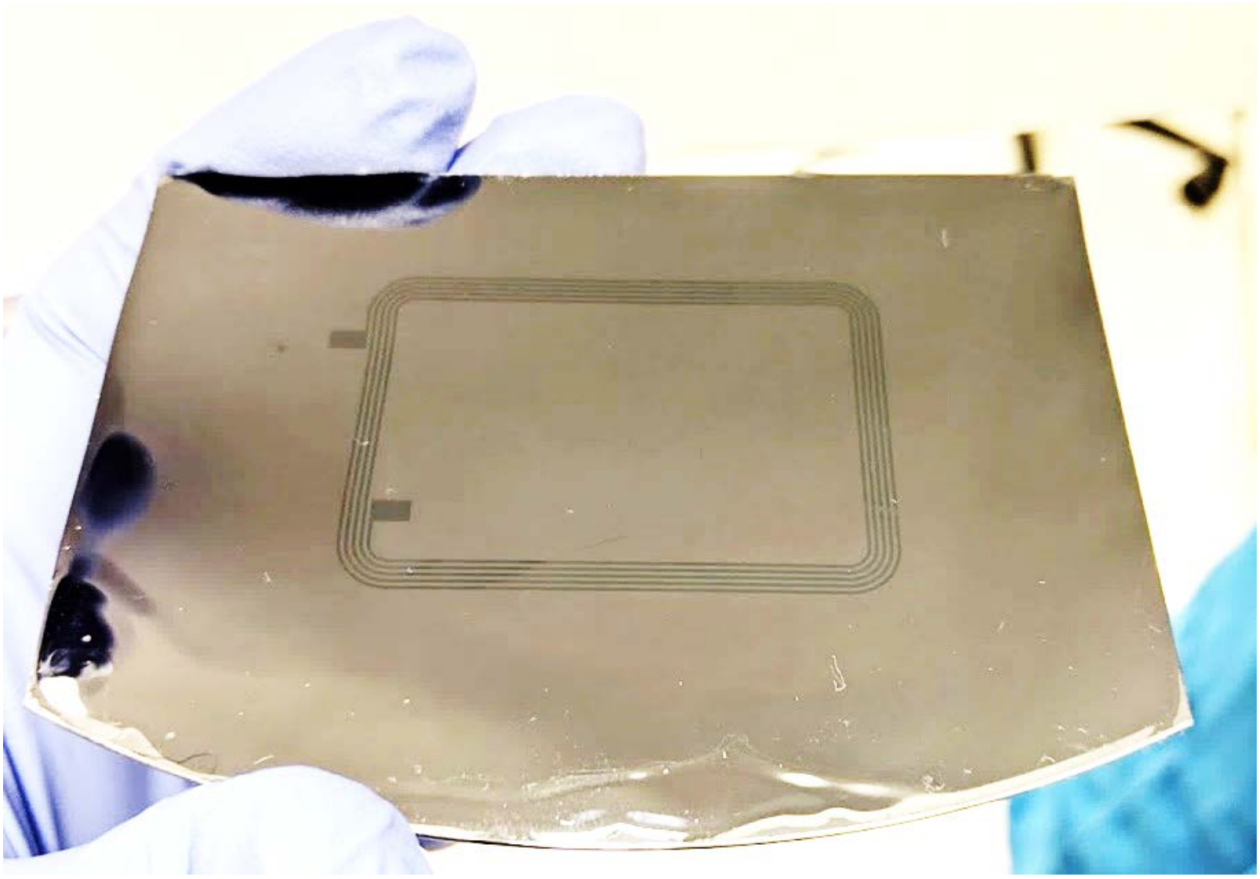


Figure 2 An example of a large-scale, photo patterned device.
Antenna approximately 7.5 cm long and 5 cm wide.

Stage of Development – Proof of Concept

The Bao Research Group fabricated and tested large-scale antennae (figure 2) using the material and manufacturing method. Next steps include scaling up material production and device fabrication processes for industrial manufacturing.

Additional related upcoming stretchable electronics innovations from the Bao Research Group include:

• A method to fabricate large area, high-resolution stretchable electronics via laser to directly transform and pattern synthesized or commercial polymer materials. (Stanford Docket S18-163.)

• A process for direct photo-patterning electronic polymers that improves device density of elastic circuits over 100x. (Stanford docket S19-138.)

• A stretchable, transparent conductor device based on photo crosslinked PEDOT:PSS with high electrical conductivity, stretchability, and direct photo patternability. (Stanford docket S20-489.)

Applications

- Neural recording/stimulation
- Neurochemical monitoring
- Wearable devices
- Stretchable, flexible organic electronic devices (e.g. LEDs, field effect transistors)

Advantages

- **Direct photopatterning** of conductive and stretchable PEDOT electrodes with aqueous stability and stable performance following solvent treatment.
- **Organic semiconductor fabrication friendly** - photopatterning performed with 365 nm UV light, which is well suited to most i-line mask aligners.
- **Higher throughput** electrode fabrication than state of the art.
- **Forgivable and reliable** process - photo crosslinking reaction has less restriction on the monomer configuration.

Publications

- Bao, Zhenan, and Yuanwen Jiang. "Directly photo-patternable, stretchable, electrically conductive polymer." U.S. Patent Application 16/867,435, filed December 24, 2020. https://patents.google.com/patent/US20200401042A1
- Myers, Andrew." New Chemistry Enables Using Existing Technology to Print Stretchable, Bendable Circuits on Artificial Skin ", Stanford News, 1 July 2021.
- Zheng, Yu-Qing, et al. " Monolithic optical microlithography of high-density elastic circuits", *Science*, 2 July 2021. DOI: 10.1126/science.abh3551

Patents

- Published Application: 20200401042
- Issued: 12,019,372 (USA)

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