Docket #: S20-489

Supramolecular network for stable, highly stretchable, conducting, and photo-patternable PEDOT:PSS

The Zhenan Bao Research Group at Stanford University has designed an intrinsically stretchable polymeric matrix that allows seamless integration with physically crosslinked PEDOT:PSS, while stabilizing its high stretchability, and high conductivity after all necessary fabrication processes, and while in use in the body. The group uses a slide-ring supramolecular network made of polyethylene glycol (PEG) based polyrotaxanes (PR), to decouple the network stretchability (with sliding crosslinkers in PR architectures) from the chain solubility (with polar polyether groups). Devices (figure 1 and 2) using the material maintain performance in the physiological environment and throughout process steps.

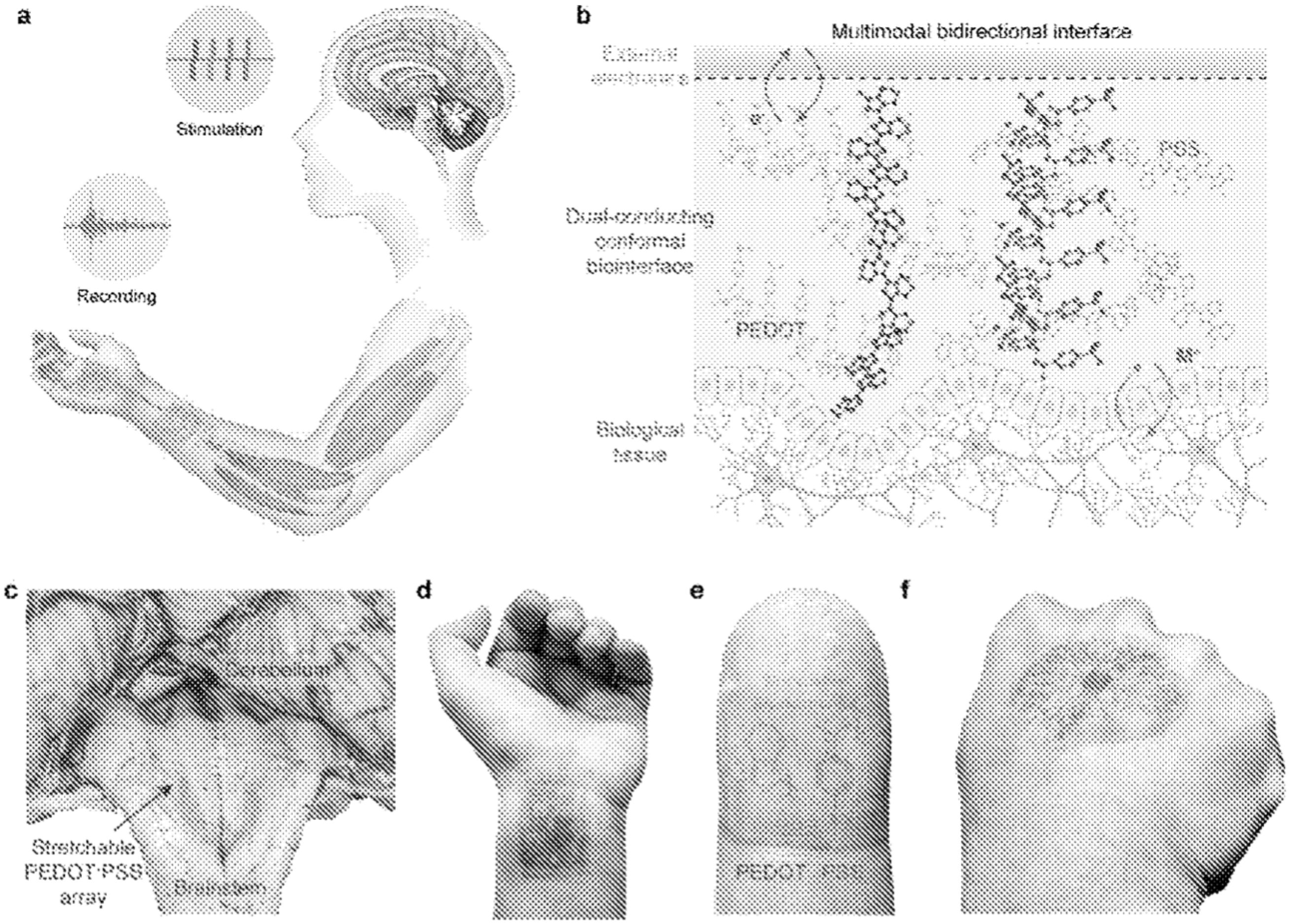

Figure 1 Examples of stretchable electronics for multimodal and conformal biointerfaces

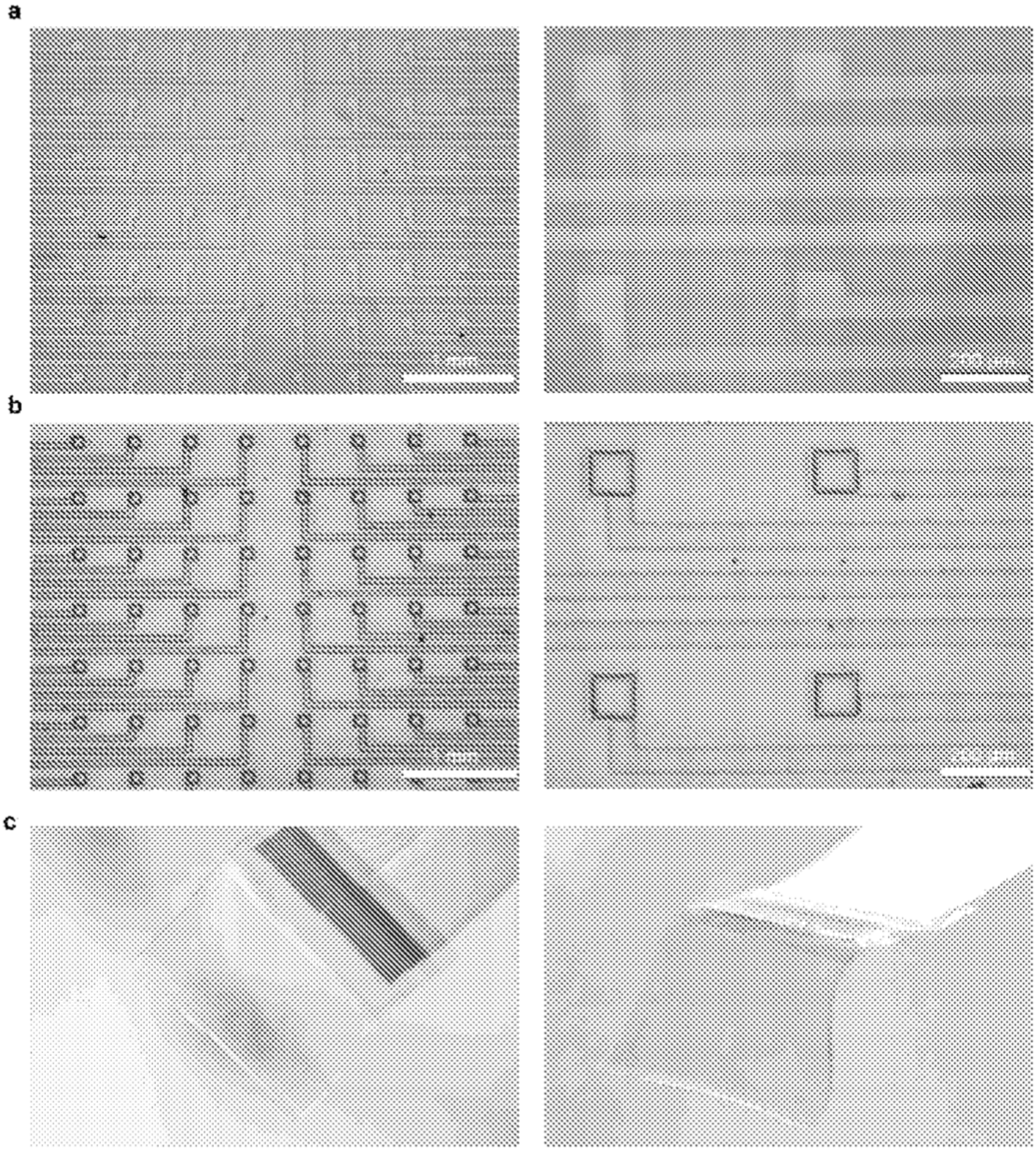

Figure 2 PEDOT:PSS electrode arrays before (a) and after (b) encapsultation, and (c) and as fabricated device.

Stage of Development- Proof of concept

The Bao Research Group has finished lab-scale production and characterization of the material, including immunohistology and feasibility studies of electrical stimulation in rats, and sEMG (surface electromyography) for humans. Future plans focus on a creating high density stretchable electrode array for bidirectional brain machine interfaces, and developing large scale material production and device fabrication processes in preparation for industrial manufacturing.

Additional related upcoming stretchable electronics innovations from the Zhenan 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 new formulation of PEDOT: PSS for direct photopatterning with maintained high conductivity and intrinsic stretchability. Stanford docket S19-101.

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

Applications

- Neural recording/stimulation and integrated biopotential sensors
- Wearable devices
- Flexible displays and other stretchable, flexible electronic devices

Advantages

- **More stable** performance after all necessary fabrication processes and while in use in the body.
- **Improved stretchability and conductivity** of polymer at record-high values (~2500 S/cm with at least 100% stretchability).
- **Better immunohistology and overall performance** than rigid biopotential sensors - reduced interfacial impedance between electronically conducting circuits and ionically conducting tissues.

Patents

- Published Application: WO2022159512

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