Docket #: S17-306

Fully elastic dielectric polymer for photolithography of flexible electronics

Engineers in Prof. Zhenan Bao's laboratory have developed a fully elastic, highly stretchable fluorinated polymer that can be used as a photoresist with standard lithography techniques for precise patterning of flexible electronic devices. Currently, commercially available photoresists are either rigid or have a porous structure that causes swelling when treated with solvents used in lithographic patterning. This problem prevents direct fabrication of fully stretchable electronics. This new intrinsically stretchable dielectric photoresist material does not swell like conventional elastomers because it is chemically orthogonal to most common solvents. In addition, it can be patterned in submicron meter scale to print fully stretchable thin-film transistor arrays. These features make this elastic photoresist a perfect candidate to be used as an elastic substrate and passivation layer for low-cost, mass production of next generation stretchable electronics including displays, wearable electronics and biomedical devices.

Stage of Research
The inventors have fabricated an intrinsically stretchable semiconductor in a transistor array using this fluorinated elastomer dielectric material as a substrate, dielectric layer and passivation. This array demonstrated high electrical performance and was incorporated into a fully stretchable light-emitting diode (LED) display. In addition, this material and photoresist technique was used to fabricate a flexible neurostimulation device (see details in publication below).

Applications

- **Fabrication of flexible electronics** - dielectric substrate and passivation layer and stretchable photoresist for mass production of flexible electronic

devices with end-user applications such as:
    - biomedical devices
    - wearable electronics
    - displays

Advantages

- **Fully elastic and highly stretchable material:**
    - fluorinated elastomer has >200% stretchability
    - stretchable photoresist is ideal for compatibility with other elastomeric substrates used in flexible electronics
- **Precise patterning:**
    - compatible with conventional photolithographic processes
    - directly patternable with sub 10 um feature size using conventional photolithography techniques
- **Maintains shape in solvents:**
    - chemically orthogonal to all non-fluorinated solvents
    - does not swell - unlike other porous elastomers, this photoresist material is extremely tolerant to most organic solvents for fabrication

Publications

- Y. Liu, J. Liu, S. Chen, T. Lei, Y. Kim, S. Niu, H. Wang, X. Wang, A.M. Foudeh, J.B.-H. Tok and Z. Bao Soft and elastic hydrogel-based microelectronics for localized low-voltage neuromodulation *Nature Biomedical Engineering* 3, 58-68 (2019).

Patents

- Published Application: WO2019084498
- Published Application: 20200257199
- Published Application: 20250110401
- Published Application: 20250298313
- Issued: 12,313,969 (USA)

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