

Docket #: S13-403

New Polymer Dielectrics for Transistors

Stanford researchers have developed an elastomer polymer dielectric for high performance transistors with both high gain and high transconductance, which also shows unprecedented high bias-stress stability in air and water. Although organic materials are of interest for field-effect transistors, their relatively low charge carrier mobilities have presented a challenge for practical use. This dielectric solves that challenge by combining a fluorinated polar elastomer with low ion concentration and low glass transition temperature to create an unusual double-layer capacitance effect that greatly enhances the transconductance of organic field-effect transistors (OFETs) when driven at low operating voltages. Inventors have obtained a transconductance per channel width 30 times higher than that measured for the same organic semiconductors fabricated on a different semicrystalline polymer. Using this new polymer dielectric will greatly enhance the mobility of organic transistors.

In addition to the high OFET performance, this polymer improves upon previously reported OFETs by featuring high-bias stability in air and water. Other ionic dielectrics present manufacturing challenges due to high moisture sensitivity. However, devices made from this polymer dielectric have shown high current output and low bias stress in both ambient (air) and aqueous (water) conditions. The increased compatibility of this dielectric material with standard manufacturing processes opens up avenues for large-scale production of OFETs.

Applications

- Biomedical devices
- Sensors
- Wearable electronics
- Stretchable devices

- Electronic devices
- Optoelectronic devices

Advantages

- High OFET performance
- Unprecedented high device stability in air and aqueous media (water)
- Low cost and compatible with standard manufacturing techniques to enable large scale production of OFETs
- High mobility for improved semiconductor performance
- Generally applicable to a variety of semiconducting materials beyond organic semiconductors
- Low driving voltage and low voltage operation
- Low leakage current

Publications

- Wang, C., Lee, W.-Y., Kong, D., Pfattner, R., Schweicher, G., Nakajima, R., ...
Bao, Z. (2015). [Significance of the double-layer capacitor effect in polar rubbery dielectrics and exceptionally stable low-voltage high transconductance organic transistors](#). *Scientific reports*, 5.

Patents

- Published Application: [20170098791](#)
- Published Application: [WO2016003523](#)
- Issued: [9,954,191 \(USA\)](#)
- Issued: [10,431,757 \(USA\)](#)

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