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Advance Mobility Improvement for Organic Field Effect Transistors

A method to increase dramatically—by more than 2 orders of magnitude—the mobility of organic field effect transistors (OFETs)

Avishek Aiyar, David M. Collard, Rakesh Nambiar, and Elsa Reichmanis from the School of Chemical and Biomolecular Engineering at Georgia Tech have developed a method to increase dramatically—by more than 2 orders of magnitude—the mobility of organic field effect transistors (OFETs). Their operationally simple approach uses low-intensity ultrasound to aggregate solutions of poly(3-hexylthiophene) (P3HT) within chloroform ($CHCl_3$) or other common solvents. When these ultrasound-induced aggregates are deposited onto a substrate via spin-coating, the resulting polymer film exhibits significantly higher charge transport compared to other approaches. Specifically, irradiating a P3HT-containing $CHCl_3$ solution with 40 kHz (130 W) of ultrasound for less than 5 minutes increases the film's mobility to 2.6×10^{-2} $cm^2/(V \cdot s)$ compared with a mere 4.2×10^{-4} $cm^2/(V \cdot s)$. Achieving this 100-fold improvement in charge transport did not require any additional processing or special deposition techniques.

Summary Bullets

- **Dramatic increase in mobility:** Yields a 2-order-of-magnitude increase in charge transport
- **Fast**: Achieves 100-fold improvements after a mere 5 minutes of ultrasound
- **Simple**: Requires only low-intensity ultrasound and eliminates the need for dielectric surface modifications or post-deposition treatment of the device

Solution Advantages

- **Dramatic increase in mobility:** Yields a 2-order-of-magnitude increase in charge transport
- **Fast**: Achieves 100-fold improvements after a mere 5 minutes of ultrasound
- **Simple**: Requires only low-intensity ultrasound and eliminates the need for dielectric surface modifications or post-deposition treatment of the device
- **Reproducible**: Provides more consistent results than other methods

Potential Commercial Applications

This technology provides an efficient approach for mass manufacturing high-performance large-area printed electronics for:

- Flexible integrated circuits
- Flexible electronic displays
- Medical implants and other biodegradable electronics
- Televisions (OLED) and large electronic displays
- Smart packaging
- Interactive media products (gadgets, cards, toys)
- Branding and security (counterfeiting mitigation and product compliance)
- Wearable communications devices
- Electronic paper, plastic/flexible electronics
- Solar cells
- Radio-frequency identification (RFID) tags
- Data/Memory storage
- Consumer electronics

Background and More Information

This technology was developed to provide a simpler, faster method to increase mobility/charge transport, improving the performance of electronic devices. Various methods exist for enhancing charge transport and field effect mobilities in organic thin-film transistors; however, these techniques have significant drawbacks. For example, thermal annealing followed by slow crystallization requires time-consuming processing at extremely low oxygen and moisture levels. Dielectric surface modification using self-assembled monolayers is difficult to achieve and also requires a moisture-free environment. Less complex methods exist, but they do not yield significant improvements in mobility without the use of high-purity, process-intensive synthesized polymers.

Inventors

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IP Status

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Publications

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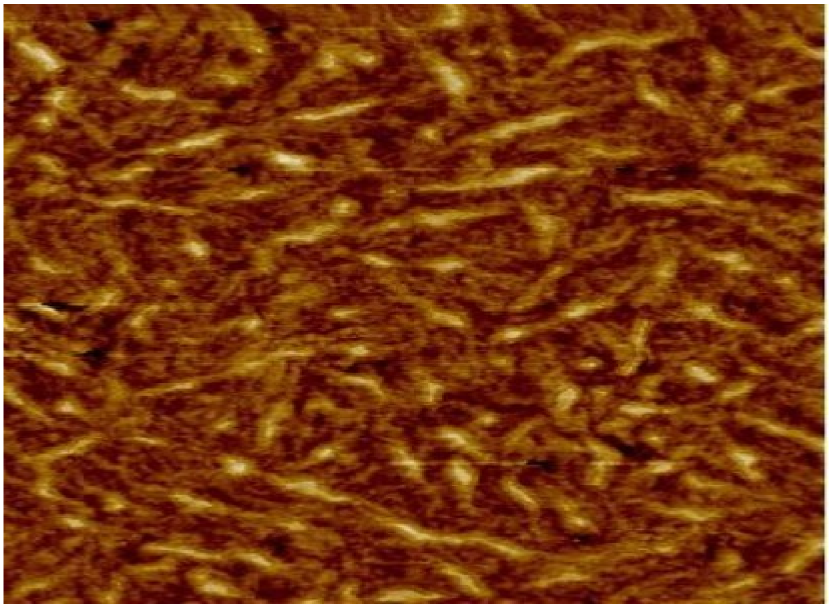
Images



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