Conductive Polymer Films Grafted on Organic Substrates
Technology #12444

Applications

This technology can be used to improve the fabrication of flexible electronics by making them more reliable and durable. Flexible electronics are of commercial interest in applications including rollable displays and wearable electronics.

Problem Addressed

Conjugated organic polymers have an inherently flexible nature that makes them ideal for manufacturing flexible electronics. Due to its high electrical conductivity and good optical transparency, Poly (3,4-ethylenedioxythiophene) (PEDOT) is of particular industrial interest. These unique properties have interesting device applications such as organic light emitting diodes (OLEDs), organic thin film transistors (OTFTs), organic photovoltaic cells, and sensors. However, the performance of these flexible devices does not measure up to industry standards due to i) weak adhesion between conducting polymers and flexible substrates and ii) the lack of appropriate patterning methods.

Technology

To address this issue, the inventors have devised an effective, one-step method to graft PEDOT onto flexible substrates. PEDOT was grafted on the surface of poly styrene (PS), a phenylene-rich polymer. The radical cations of the phenyl group in PS recombine with the radical cations of ethylenedioxythiophene (EDOT) to form a chemical bond from the PS surface. By repetitive oxidative polymerization reaction of EDOT, the surface grafted EDOT is polymerized on the PS surface. The resulting polymer film shows a tremendous enhancement in adhesion strength. This technique can be applied to any substrate with phenyl functionality. PS is a rigid substrate but the inventors have also successfully grafted PEDOT film onto flexible poly ethyleneterephthalate (PET) substrates, with high conformity to the surface of the substrate.

This technique can be applied to selectively pattern PEDOT films grafted on flexible polymer substrate. The inventors use PS as the grafted substrate and poly ethyleneoxide (PEO) for the non-grafted layer for lift-off. The PEO pattern is obtained on the PS surface by using a soft mold of poly dimethylsiloxane (PDMS). PEDOT film is deposited on top of the patterned PEO/PS layer via oxidative chemical vapor deposition (oCVD). PEDOT is grafted only where PS is exposed at the surface, and is not grafted on the PEO. Therefore, the PEDOT layer on PEO can be easily lifted off by water because PEO is highly miscible with water. In this way, sub-micron sized, selective-patterned PEDOT film grafted on flexible substrates can be obtained using lift-off technique, which can be a breakthrough for high-end flexible electronic devices.

Advantages

- Simple, one-step process yields dramatic improvement in polymer film adhesion strength
- Method can be used to graft polymers on rigid or flexible substrates
Can obtain selectively patterned polymer films, a breakthrough for flexible electronics

**Categories For This Invention:**
- Electronics & Circuits
- Materials

**Intellectual Property:**
Conductive polymer films grafted on organic substrates
- Issued US Patent 9,530,965
- Conductive polymer films grafted on organic substrates
- Issued US Patent 8,779,071

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**Publications:**
Grafted Conducting Polymer Films for Nano-Patterning onto Various Organic and Inorganic Substrates by Oxidative Chemical Vapor D
Advanced Materials
September 11, 2007, p. 2863-2867

**External Links:**
G-Lab at MIT
http://web.mit.edu/gleason-lab/

**Image Gallery:**

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