

Materials

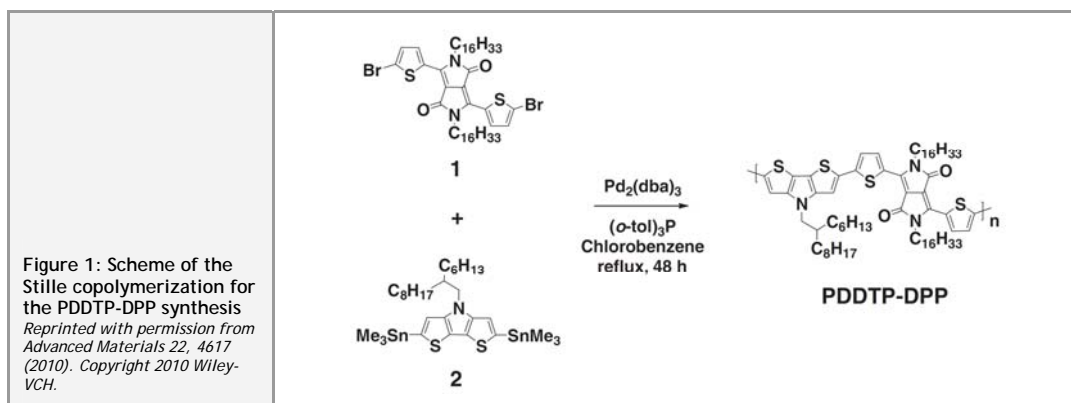
Carnegie Mellon Univ.: Transistor paint, high mobilities in acceptor donor polymer semiconductors

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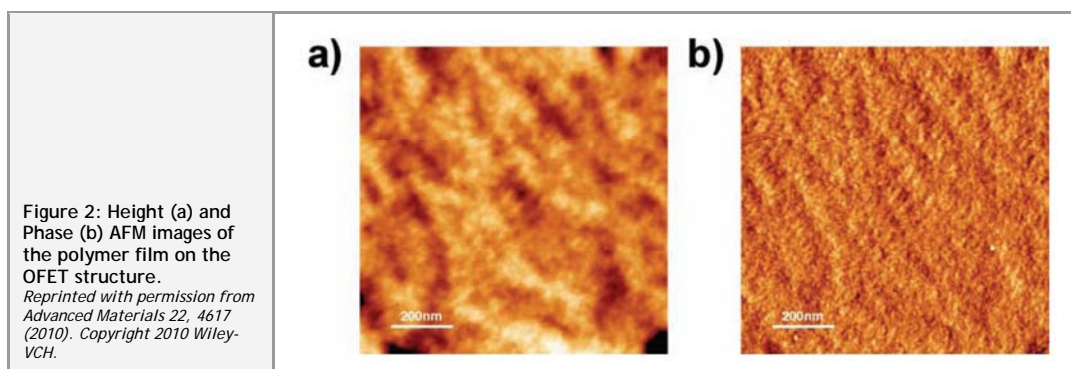
Designing chain microstructure of Donor-Acceptor alternated copolymers: paving the road towards an improved generation of polymeric semiconductors



These last years have seen an increasing number of publications related to organic field effect transistors based on polymers that form nanofibrils like regio-regular P3ATs (Poly-Alky-Thiophenes). It is postulated that this morphology can lead to high charge mobility ($0.1 \text{ cm}^2/\text{V}\cdot\text{s}$) thanks to π -stacked polymer backbone and lamellar packing of the alkyl side chain. In this paper, **T.L. Nelson**, **R.D. McCullough** and their colleagues from the **Carnegie Mellon University** demonstrated another way to perform high mobility organic field effect transistors thanks to polymers with non-fibrillar architectures and small granular morphologies. These devices are called "transistors paints". For example these polymer materials can incorporate sparse side chains to suppress nano-fibrillar formation and promote smaller granular morphology. The goal of that is the improvement of the transistor reproducibility. The strategy developed in this work is the use of strong donor and acceptor molecules to drive a strong assembly of the π -system. To do that, the authors used the diketopyrrolopyrrole (DPP) as the acceptor block and the dithienopyrrole (DTP) as the donor one. The microstructure of the copolymer thin films was investigated by grazing incidence wide angle X-ray scattering (GIWAXS) and results showed pronounced peaks up to 4 orders indicating the presence of highly ordered lamellar sheets perpendicular to the substrate. The transistors based on these new synthesized copolymer exhibits hole mobility as high as $0.41 \text{ cm}^2/\text{V}\cdot\text{s}$ and average mobility of $0.29 \text{ cm}^2/\text{V}\cdot\text{s} \pm 0.04$ for channel lengths ranging from 10 to 40 μm . This demonstrated that judicious molecular design and fibrillar suppression leads to materials with reproducible morphologies and high charge transport properties.



The authors have developed during these last years different strategies to perform such non-fibrillar polymers. With the use of strong acceptor and strong donor systems they succeeded in the fabrication of reproducible and high performance copolymer materials.



These acceptor-donor materials are certainly representing the next generation of the polymer based field effect transistors. This non-fibrillar morphology with smaller grain boundaries, leading to high reproducible mobility is a good way to improve the performances of actual organic electronic circuits that suffer until now from the discrepancy of the individual component characteristics.

"Transistor Paint: High Mobilities in Small Bandgap Polymer Semiconductor Based on the Strong Acceptor, Diketopyrrolopyrrole and Strong Donor, Dithienopyrrole" ; T.L. Nelson, T.M. Young, J. Liu, S.P. Mishra, J.A. Belot, C.L. Balliet, A.E. Javier, T. Kowalewski, R.D. McCullough : *Advanced Materials* 22, 4617 (2010).