Materials

Polyera Corp., BASF: Air-stable electron-transporting organic semiconductor with high mobility

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A novel n-type organic polymer semiconductor with high mobility

The authors from **Polyera Corp** and **BASF** have presented a new organic semiconductor and its characterization. The polymeric semiconductor consists of naphthalene-bis(dicarboximide) based groups that are interconnected by bithiophene groups. The LUMO is determined at -4.0 eV. The low optical bandgap of 1.45 eV is attributed to regioregularity of the polymeric backbone.

Electron mobilities outperforming most small-molecule based organic electron-conducting semiconductors (>0.1 cm^2/Vs) are demonstrated using Au bottom-contact top-gate structures with a variety of polymeric gate-dielectrics on both glass and PET substrates by solution processing. Threshold voltage is in all cases positive. The on-off current ratio is in general higher than 10^6. The high mobility is maintained when the semiconductor is printed (gravure, flexography and inkjet are demonstrated), even when also the gate dielectric is printed.

Contrary to former reports on polymeric hole-conducting organic semiconductors, no decrease of mobility is observed for dielectrics with higher permittivity values. It is assumed that the alkyl-tails on the semiconductor cores impose some distance (> 1 nm) between the charge transport channel and the gate dielectric and therefore reduce this effect. No dependence of the device performance on polymer molecular weight or polydispersity is furthermore observed.

A study of device stability is also reported. Over a period of several weeks in air the top-gate devices show no substantial decrease in mobility or on-off ratio. For a specific gate dielectric a slight increase of V_{on} is seen. Under conditions of increased humidity, a decrease in transistor performance is only seen at RH=70% and higher.

Finally, the n-type transistors based on the gravure printed semiconductor and printed gate dielectrics are integrated in a P3HT based p-type process for the demonstration of organic complementary inverters. High gains are observed (> 26 at V_{DD} = 20 V).

This paper propose then an air-stable electron-transporting organic semiconductor offering high mobility (>0.1cm2/Vs). This mobility is even in the range of hole mobility in p-type organic semiconductors. It has also been shown that the integration of printed n-type and p-type transistors was possible. Because the electron mobility in the new organic semiconductor approaches the hole mobility in p-type organic semiconductors, complementary circuits are obtained with an excellent noise margin. Moreover, they are printable and have excellent air stability.

"A high-mobility electron-transporting polymer for printed transistors" ; H. Yan, Z. Chen, Y. Zheng, C. Newman, J.R. Quinn, F. Dötz, M. Kastler, A. Facchetti : ***Nature* 457**, 679 (2009).