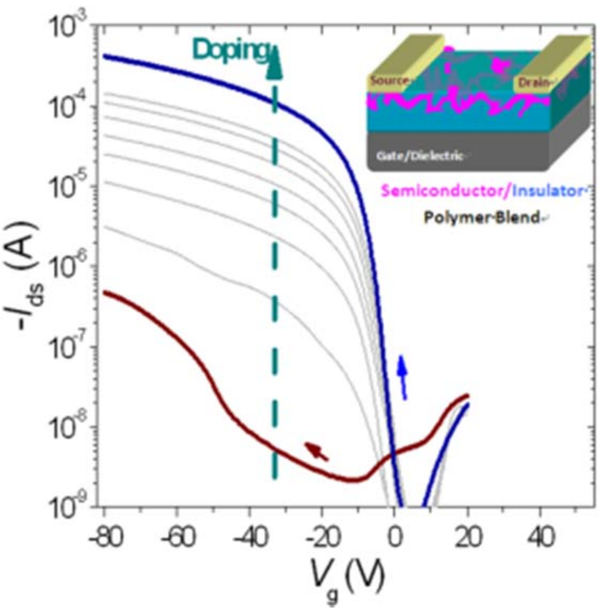
Scientific Highlight

Moderate doping leads to high performance of semiconductor/insulator polymer blend transistors

Polymer transistors are being intensively developed for next-generation flexible electronics. Blends comprising a small amount of semiconducting polymer mixed into an insulating polymer matrix have simultaneously shown superior performance and environmental stability in organic field-effect transistors compared with the neat semiconductor. Here a group of scientists including Norbert Koch, member of IRIS Adlershof, shows that such blends actually perform very poorly in the undoped state, and that mobility and on/off ratio are improved dramatically upon moderate doping. Structural investigations show that these blend layers feature nanometre-scale semiconductor domains and a vertical composition gradient. This particular morphology enables a quasi three-dimensional spatial distribution of semiconductor pathways within the insulating matrix, in which charge accumulation and depletion via a gate bias is substantially different from neat semiconductor, and where high on-current and low off-current are simultaneously realized in the stable doped state. Adding only 5 wt% of a semiconducting polymer to a polystyrene matrix, we realized an environmentally stable inverter with gain up to 60.

This new approach promotes the OFET performance while providing a simple fabrication process.

With this guidance, highly transparent transistors with field-effect mobilities comparable to that of amorphous silicon, combined with environmental stability and mechanical robustness, might become feasible.



The effect of doping on the transistor performance of P3HT/PS blends and neat P3HT. In-situ evolution of the transfer characteristics (V_{ds}=-5V, linear regime) on exposure time in 'dilute air' (N_2 atmosphere with O_2 concentration ~1 ppm and H_2O ~1 ppm). P3HT/PS (5% P3HT)

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