Optical switching of carrier transport in transistors based on an organic bicomponent blend

Carroli Marco[1], Heder Martin[2], Hecht Stefan[2], Orgiu Emanuele[1], Samorì Paolo[1]

[1] Université de Strasbourg, CNRS, ISIS, 67000 Strasbourg, France;
[2] Humboldt-Universität zu Berlin, Department of Chemistry & IRIS Adlershof, 12489 Berlin, Germany

E-mail: carroli@unistra.fr

Novel multifunctional devices can be fabricated by combining organic semiconductors with molecules possessing different chemical, optical and electrical properties. Diarylethene molecules (DAEs) have attracted a great deal of attention thanks to their efficient interconversion between two thermodynamically stable isomers that exhibit remarkably different electronic properties, allowing to introduce controlled photo-modulable trap levels in the semiconductor bulk.[1] We have achieved bi-functionality exploiting DAEs in combination with PDVT-8 or PCDTPT polymers as a bi-component active layer in organic thin-film transistors (OTFTs). These polymers have been chosen as p-type semiconductors because they feature high field effect mobility (up to 1 $cm^2V^{-1}s^{-1}$) and HOMO energy levels that allow electronic interaction with the closed form of DAE-Me.[2,3] These findings are of interest for the development of high-performing optically gated electronic devices, such as switches and multilevel non-volatile optical memories,[4] therefore for a new generation of electronics. Finally, we explore the possibility of introducing a third functional component to control the modulation of the surface charge density at the semiconductor/dielectric interface.

Funding: This work was supported by the EC through the Marie Sklodowska-Curie ITN project iSwitch (GA-642196), the Agence Nationale de la Recherche through the LabEx project Chemistry of Complex Systems (ANR-10-LABX-0026_CSC) and the International Center for Frontier Research in Chemistry (icFRC).

Acknowledgement: We thank Dr. Tim Leydecker for helpful discussions on experimental design and data analysis.

References:

[1] Orgiu, E. ; Crivillers, N.; Herder, M.; Grubert, L.; Pätzel, M.; Frisch, J.; Pavlica, E.; Duong, D.T.; Bratina, G.; Salleo, A.; Koch, N.; Hecht, S.; Samorì, P., *Nature Chemistry*, **2012** 4, 675–679.

[2] Chen, H.; Guo, Y.; Yu, G.; Zhao, Y.; Zhang, J.; Gao, D.; Liu, H.; Liu, Y., *Advanced materials*, **2012**, 24, 4618–22.

[3] Ying, L.; Hsu, B.B.Y.; Zhan, H.; Welch, G.C.; Zalar, P.; Perez, L.A.; Kramer, E.J.; Nguyen, T.; Heeger, A.J.; Wong, W.; Bazan, G.C., *Journal of the American Chemical Society*, **2011**, 133, 18538–18541.

[4] Leydecker, T.;Herder, M.; Pavlica, E.; Bratina, G.; Hecht, S.; Orgiu, E.; Samorì, P., *Nature Nanotechnology*, **2016**, 11, 769–775.