Polymer-sorted semiconducting carbon nanotubes for high-mobility field-effect transistors and near-infrared electroluminescence

Jana Zaumseil

Institute for Physical Chemistry, Universität Heidelberg, D-69120 Heidelberg, Germany
Tel.:+49-6221-545065, E-mail: zaumseil@uni-heidelberg.de

Field-effect transistors based on dense networks of single-walled carbon nanotubes (SWNT) are competitive alternatives to other solution-processable semiconductors. Purely semiconducting SWNTs with different bandgaps can be extracted and enriched by dispersion with various polyfluorenes. Top-gate FETs fabricated with thin films of these SWNT and a hybrid gate dielectric [1] show balanced ambipolar transport with on/off ratios above 10^6 and high effective mobilities (50 $cm^2V^{-1}s^{-1}$) at low voltages (<5V, Fig. 1a) as well as near-infrared electroluminescence with narrow linewidths (Fig. 1b). Charge transport paths within random and semi-aligned networks of SWNTs depend on network density, bandgap distribution and alignment. Electroluminescence maps of these networks, which are markedly different from the corresponding photoluminescence (PL) images (Fig. 1c), visualize preferential current paths in such networks [2,3]. The fraction of emission from different species of nanotubes depends on the applied voltages and resulting current density. At very high carrier densities trion (charged exciton) emission is observed in addition to excitonic emission [4].

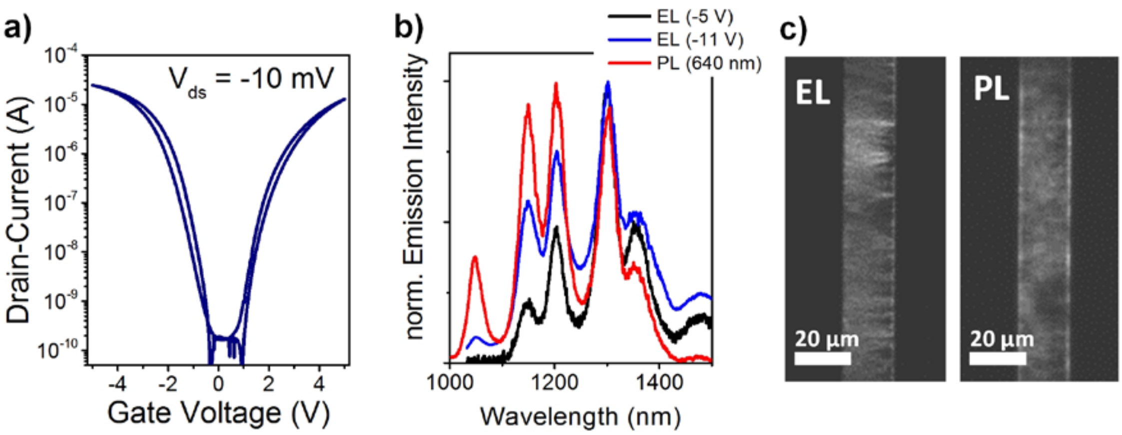

Fig. 1. a) Transfer characteristics of an ambipolar s-SWNT transistor, b) EL and PL spectra and c) spatial maps of a transistor channel during ambipolar operation.

Acknowledgment

This research was funded by European Research Council under the European Union's Seventh Framework Programme (FP/2007-2013) / ERC Grant Agreement No. 306298 (EN-LUMINATE).

References

1. S.P. Schießl et al., *ACS Appl. Mater. Interfaces* 7, 682 (2015).
2. F. Jakubka et al., *ACS Nano* 7, 7428 (2013).
3. S.B. Grimm et al., *Adv. Mater.* 26, 7986 (2014).
4. F. Jakubka et al., *ACS Nano* 8, 8477 (2014).