High performance organic light emitting transistor based on hexylstyryl tetracene

A.Dadvand,[a,b] F.Cicoira,[a] C.Santato,[b] C.Harnagea,[a] A.Pignolet,[a] H.Meng,[c] F.Rosei,[a] D.F.Perepichka,[b]

[a] INRS-EMT, University of Quebec,
[b] Department of Chemistry, McGill University
[c] DuPont Experimental Station

Up-growing interest in organic semiconducting materials results from their successful application in optoelectronic devices such as Organic Field Effect Transistors (OFET), Organic Light Emitting Diodes (OLED), and Photovoltaic (PV) cells. The unlimited choice of organic materials provides unique possibilities to develop integrated circuit technologies based on OFETs for various large areas, low-cost applications. A large variety of organic semiconductors and modification of their molecular and morphological structure make it possible to build transistors for different type of applications. We fabricated high performance transistors employing well-known organic semiconductors (OSCs) such as pentacene as well as newly synthesized OSCs.

Organic light emitting transistors (OLETs) are a new type of devices leading towards nano-scale light sources and highly integrated optoelectronic devices. This structure is ideal to improve the electroluminescence quantum efficiency and lifetime of OSCs due to the different driving conditions comparing to OLEDs. We used a new synthesized tetracene derivative, [2-(4-hexylstyryl) tetracene] (HST), as an active layer to fabricate OLETs. HST is a conjugated trans-phenylvinylene substitutes linked to tetracene core. For HST vacuum sublimated films, we carried out optoelectronic characterizations in field effect transistor configuration and also AFM measurements of films grown at different deposition fluxes and with variable thickness. The HST film grows in circular shape and almost covers the whole substrate with relatively large grains comparing to pentacene. Continuous films with large grains are formed at low nominal thickness, which is important for OFET applications since charge transport occurs within the first monolayer.

References:

[1] C. T. Kuo, S. Z. Weng, Adv. Tech., 13, 753–758 (2002)

[2] Hepp, A. et al. Phys. Rev. Lett., 91, 157406 (2003)

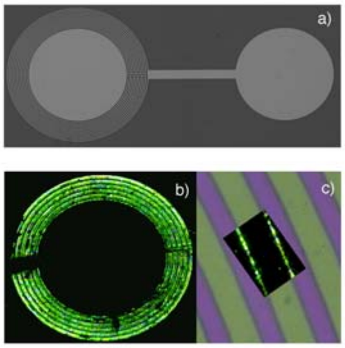
[3] Rost, C. et al. Appl. Phys. Lett., 85, 1613–1615 (2004)

[4] Bader, M. A. et al. J. Opt. Soc. Am. B 19, 2250–2262 (2002)

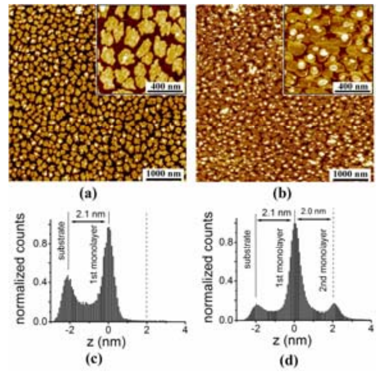
[5] E. J. Meije et al. Nature Materials, 2, 678–682 (2003)

[6] Michele Muccini, Nature Materials, 5, 605-613 (2006)

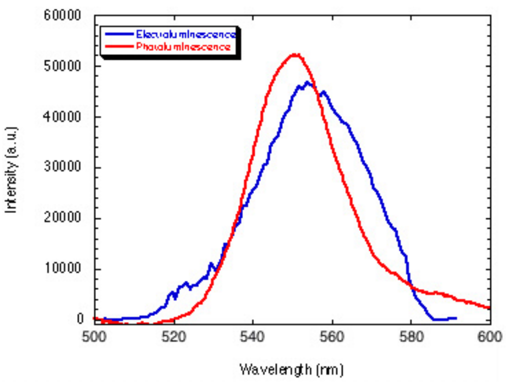
[7] A. Hepp et al. Phys. Rev. Lett., 91, 157406 (2003)



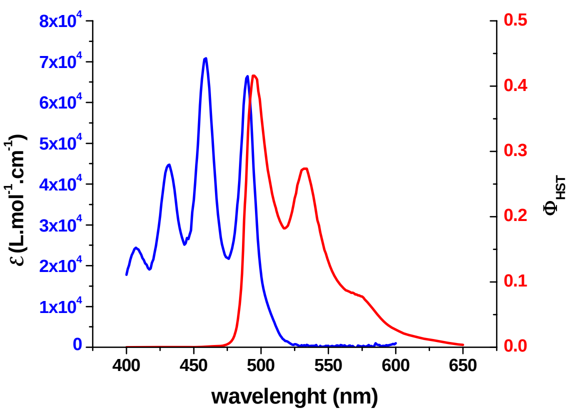
Optical images of: a) Interdigitated bottom-contact device b) Green electroluminescence of HST-LEFT c) magnified contacts and localized light emission



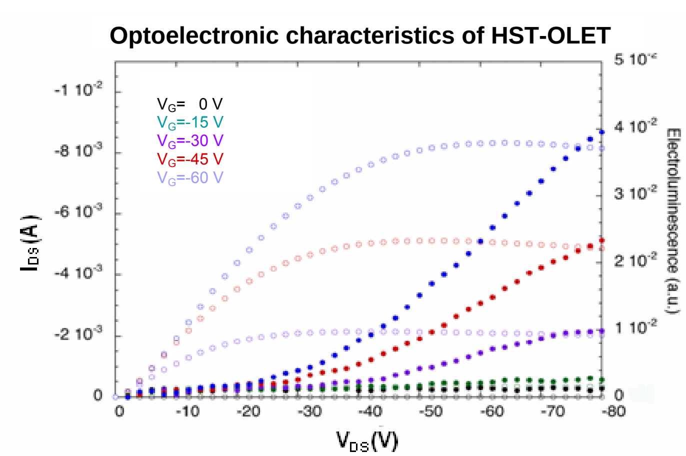
AFM images and corresponding height histograms of HST films vacuum sublimed at 0.2 A°/s.

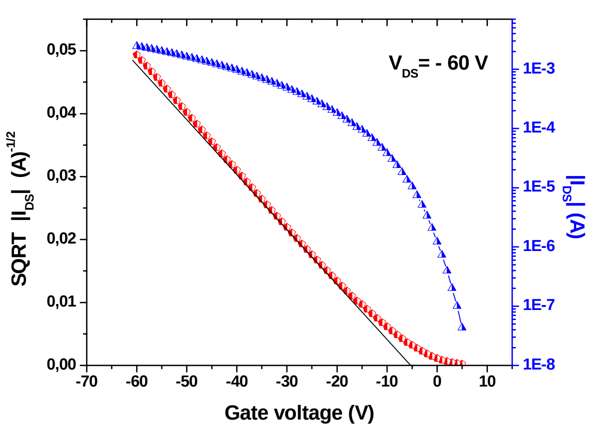


Electroluminescence spectrum (blue) of a HST-LET biased at Vds = Vg = - 60 V and photoluminescence spectrum (red) of the same film



The extinction coefficient and normalized fluorescence spectrum versus wavelength of HST molecule dissolved in 98% dichlorobenzene.





Transfer characteristics of a HST-OFET (deposition rate = 0.2 A°/s, nominal thickness = 18 nm, W/L=18800/40 µm/µm)