Abstract Submitted
for the MAR13 Meeting of
The American Physical Society

Controlling Leakage Currents in Organic Field-Effect Transistors using Molecular Dipole Monolayers on Nanoscale Oxides JOSUE F. MARTINEZ HARDIGREE, THOMAS DAWIDCZYK, ROBERT IRELAND, GARY JOHNS, BYUNG-JUN JUNG[1], NINA MARKOVIC, HOWARD KATZ, Johns Hopkins University — Self-assembled monolayers (SAM) have been explored as easily-processed, ultrathin interfacial layers in organic field-effect transistors (OFETs) for tuning the threshold voltage (Vt). We investigated the influence of Fermi-level pinning of the gate electrode by SAMs on leakage currents in OFETs fabricated on highly-doped n- and p-type Si gates with an intentionally marginal-quality, high leakage 8 nm SiO_2 dielectric. Two dipolar alkyl SAMs, octyltriethoxysilane (OTS) and its fluorinated analogue (FOTS), were employed under a 40 nm active layer of a naphthalenetetracarboxylic diimide (NTCDI) derivative. Transistors on nSi displayed more positive Vt for OTS (+0.23 V) and FOTS (+1.09 V) than bare oxide (-0.56 V), while OFETs on pSi showed a lower Vt for OTS (+0.26 V) and a higher Vt for FOTS (+1.25 V) devices relative to bare oxide (+1.15 V). Differences in gate and subthreshold leakage between bare and SAM-treated oxides match the trends in Vt. Scanning Kelvin-probe measurements were consistent with this trend, indicating FOTS made both nSi and pSi oxide surfaces more negative relative to bare oxide, while OTS treatment resulted in more positive surface potentials on pSi and more negative surface potentials on nSi.

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Date submitted: 17 Dec 2012 Electronic form version 1.4