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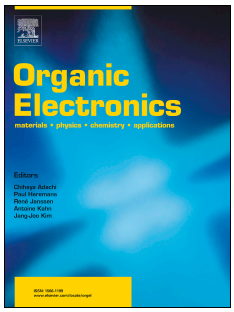

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PII: S1566-1199(17)30105-2

DOI: 10.1016/j.orgel.2017.03.002

Reference: ORGELE 3999

To appear in: *Organic Electronics*

Received Date: 21 December 2016

Revised Date: 27 February 2017

Accepted Date: 4 March 2017

Please cite this article as: N.K. Za'aba, J.J. Morrison, D.M. Taylor, Effect of relative humidity and temperature on the stability of DNTT transistors: A density of states investigation, *Organic Electronics* (2017), doi: 10.1016/j.orgel.2017.03.002.

Effect of Relative Humidity and Temperature on the Stability of DNTT Transistors: A Density of States Investigation

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Abstract

Exposure to moisture and elevated temperatures usually results in significant degradation of organic thin film transistor (OTFT) performance. Typical observations include reduced mobility, unstable threshold voltage and the appearance of hysteresis in electrical characteristics. In this contribution we investigate the effects of environmental conditions on OTFTs based on DNTT, a high-mobility, small-molecule, organic semiconductor, with polystyrene (PS) as the gate insulator. Device characteristics were measured after consecutive 30-minute exposures to a relative humidity (RH) that was gradually increased from 20% to 80% with temperature fixed at 20°C and for temperatures increasing from 20°C to 90°C with RH held at 10%. Despite significant negative shifts in turn-on and threshold voltages, only slight changes in the hole mobility were observed at the highest RH and temperature. The DNTT density of states (DoS) extracted from transfer characteristics in the linear regime using the Grünewald approach showed little change with environmental conditions. In all cases, the DoS decreased from ~1 x 10^{20} down to ~1 x 10^{17} cm^{-3} eV^{-1} in the 0.45 eV energy range above the hole mobility edge. Some evidence was obtained for a weak trap feature between ~0.25 and 0.35 eV above the mobility edge. These results confirm the high stability of DNTT as a semiconducting material and that OTFT instability observed here is associated almost entirely with a flatband voltage shift caused by hole trapping in the polystyrene gate dielectric or at the polystyrene/DNTT interface.

Key Words: OTFT, DNTT, Density of States, Environmental Effects