Instabilities in sexithiophene thin film transistors

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Abstract

One of the most important stability issues in organic Thin Film Transistors (TFTs) is the shift in the threshold voltage after prolonged applied bias to the gate electrode [1]. This variation in device parameter leads to unsteady characteristics and hence to unreliable devices.
The work will present a systematic study of the threshold voltage shift as a function of stress time, stress bias and temperature. It is observed that the kinetics of threshold voltage shift is well described by a formalism developed to interpret threshold voltage shift in a-Si TFTs where the threshold voltage shift follows a stretched hyperbola behaviour. Although this phenomenological model can adequately describe the data, it is very likely that the microscopic process responsible for the instability in organic transistors is different from the one reported for a-Si TFTs. The interesting aspect of the model is that it gives parameters to quantify the transistor stability and therefore provide feedback information for the fabrication procedures. We believe that some fabrication step, (for example atmospheric contamination), is the key to understand the instability process.
The study of the kinetics of the threshold voltage shift is complemented with a detailed analysis of the subthreshold slope of the transistor transfer curve. This parameter can be related with the number of traps or interface states, and provides further insight into the microscopic mechanisms responsible for the instability. We observed major changes occurring in the subthreshold slope at a well-defined temperature of 240-250 K. Furthermore, the gate voltage stress also induces changes in the subthreshold swing.
It is also confirmed that this type of instability in organic transistors is fully reversible. Therefore we also address the relevant question, of how much instability can be tolerated, and how we can handle this instability in practical circuits.

[1] M. Matters, D. M. de Leeuw, P. T. Herwing, and A. R. Brown, Synthetic Metals, 102 (1999) 998-999.

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