2.4 Improving the operational stability of polymer transistors through passivation of water-induced traps

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Organic-based electronics are of great potential for applications such as flexible, bendable displays, conformable sensor arrays and artificial skin. Their advantages range from their mechanical flexibility and their large-area printability to compatibility with low-temperature processing and thus compatibility with not only glass substrates, but also with bendable plastic and paper substrates.[1] Furthermore, organic semiconductors can be customized and adapted through molecular design and chemical synthesis. Significant advances in the development of organic semiconductors let to charge carrier mobilities exceeding that of amorphous silicon and contact and interface engineering and device optimization enabled megahertz operation of organic transistors.[1]

A remaining challenge however, is the environmental and operational stability of organic devices. One unanimously reported cause of such operational instabilities are water induced traps that affect the performance of various devices, such as thin-film transistors and diodes [2-4]. In organic transistors, such traps induce undesired shifts of the threshold voltage during operation and therefore are especially problematic when targeting sensing applications or active matrix displays. In the latter case, the transistors supply the currents to illuminate the pixels at a specific brightness and stable operation is a requirement. Recent findings show that water-induces traps can be passivated by the addition of particular (non-doping) molecular additives, leading to significant improvements in the device performance and the operational stability of polymer transistors [2]. We will show that threshold voltage shifts during operation can be remarkably reduced, as measured in both constant-current and constant-voltage stress experiments, discuss the underlying mechanisms and extend the concept from on-state bias stress to off-state bias stress stability.

Figure 1: Improved transistor performance of top-gate, bottom-contact IDTBT thin-film transistors (channel length: 20 µm, channel width: 1mm) with (black) and without (orange) 10 wt% of F2TCNQ, device architecture of the organic transistors and chemical structure of IDTBT (indacenodithiophene-co-benzothiadiazole).

References