Bias stress effect in organic thin film transistors operating in irradiation-activated electrolyte

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In the present work, we report on solution-processed electrolyte-gated organic thin film transistors (EGOTFTs) stemming from in-situ photo-induced-generation of mobile ions in polymeric gate dielectrics. The latter are made of PMMA containing a photoacid generator (PAG) for producing upon UV irradiation an electrolyte with potentially mobile ions [1]. Particular emphasis is placed on the modulation of the source (S)-drain (D) output current (I_{DS}) of top-gate (PEDOT:PSS) bottom-contact (Au or ITO as S/D electrodes) p-type (P3HT)-based transistors operating in the linear regime under the application of fixed gate bias (V_{GS}). I_{DS} is recorded at the drain electrode by applying a square pulsed S/D voltage (-1V/0.2 s) at limited time intervals. Figure 1 shows the I_D-t characteristics in logarithmic representation of UV-irradiated devices with Au S/D electrodes, using a 350nm-thick PAG-PMMA layer formed onto a 20 nm-thick P3HT layer under fixed V_{GS}=-25V. Similar I_{DS} as time tends to infinity are recorded for devices with a channel length (CL) in the 0.5 - 10 μm range.
As compared to the Au S/D electrode devices, UV-irradiated devices with interdigitated ITO electrodes (with variable 50-200 μm CL and channel width, W=30 mm), using a 350nm-thick PAG-PMMA layer formed onto a 20 or 50 nm-thick P3HT layer exhibit the same trend in the maximum recorded I_{DS} (V_{GS}=-25V) as depicted in the inset of Figure 2 for V_{DS} = ± 1V. This clearly reveals that at long stress times, I_{DS} depends very little on the channel length and is dominated by S/D contact resistances. Figure 2 shows that I_{DS} as time tends to infinity decreases as the thickness of the P3HT increases, thus indicating an enhancement of the contact resistance with the P3HT thickness. Additional features of I_{DS} modulation with time as a function of the applied V_{GS}, V_{DS}, P3HT thickness, CL, and UV-exposure time will be presented at the conference.

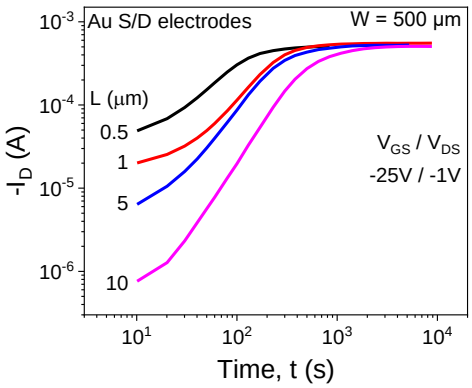

Figure 1: $\log(I_D) - \log(t)$ characteristics of UV-irradiated devices with Au S/D electrode for different channel lengths ranging from 0.5 to 10 μm, using an 80 °C-baked 350nm-thick PAG-PMMA electrolyte layer formed onto a 20 nm-thick P3HT layer under fixed V_{GS}=-25V.

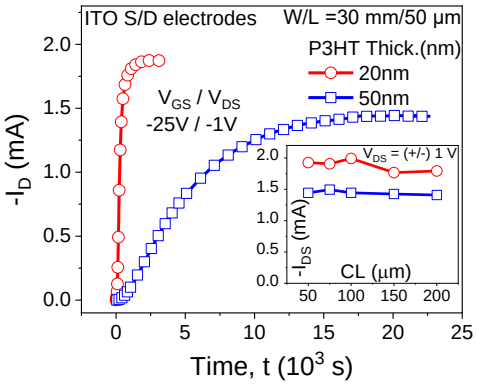

Figure 2: $I_D - t$ characteristics with interdigitated ITO electrodes, using a 20 or 50 nm-thick P3HT layer. Inset: I_{DS} vs CL characteristics of devices with L ranging from 50 to 200 μm (W = 30 mm) after stressing at V_{GS}=-25V for V_{DS} = ± 1V.

References

[1] E. Kapetanakis, Ch. Katsogridakis, D. Dimotikali, P. Argitis, and P. Normand, Adv. Electron. Mater. **6**, 2000238 (2020).

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