

Supporting Information

Contact effect in high temperature conjugated polymer transistors

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The effective mobility is calculated using the equation¹:

$$\mu_{eff} = \frac{2L}{WC} \left(\frac{\sqrt{|I_{SD}|^{max}} - \sqrt{|I_{SD}|^0}}{|V_G|^{max}} \right)^2$$

With L is the channel length, W is the channel width, C is the capacitance of the dielectric layer

$|I_{SD}|^{max}$ is the source-drain current at the maximum gate voltage $|V_G|^{max}$, and $|I_{SD}|^0$ is the source-drain current at $V_G = 0$

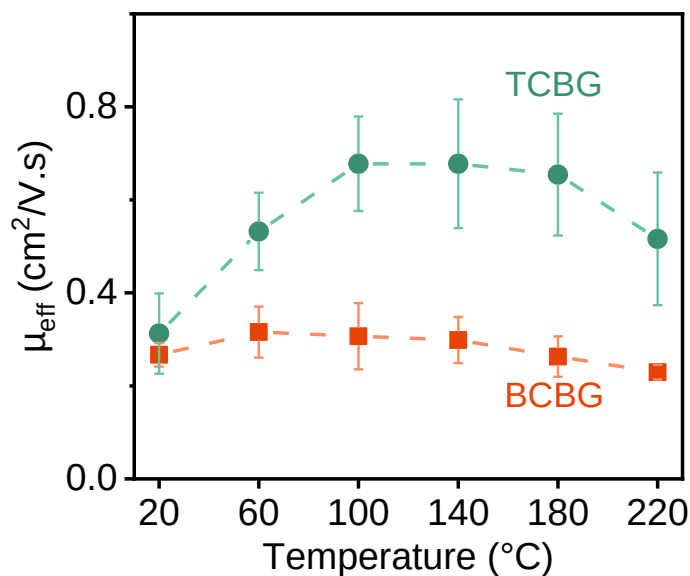


Figure S1: Temperature-dependent effective mobility (μ_{eff}) of TCBG and BCBG devices

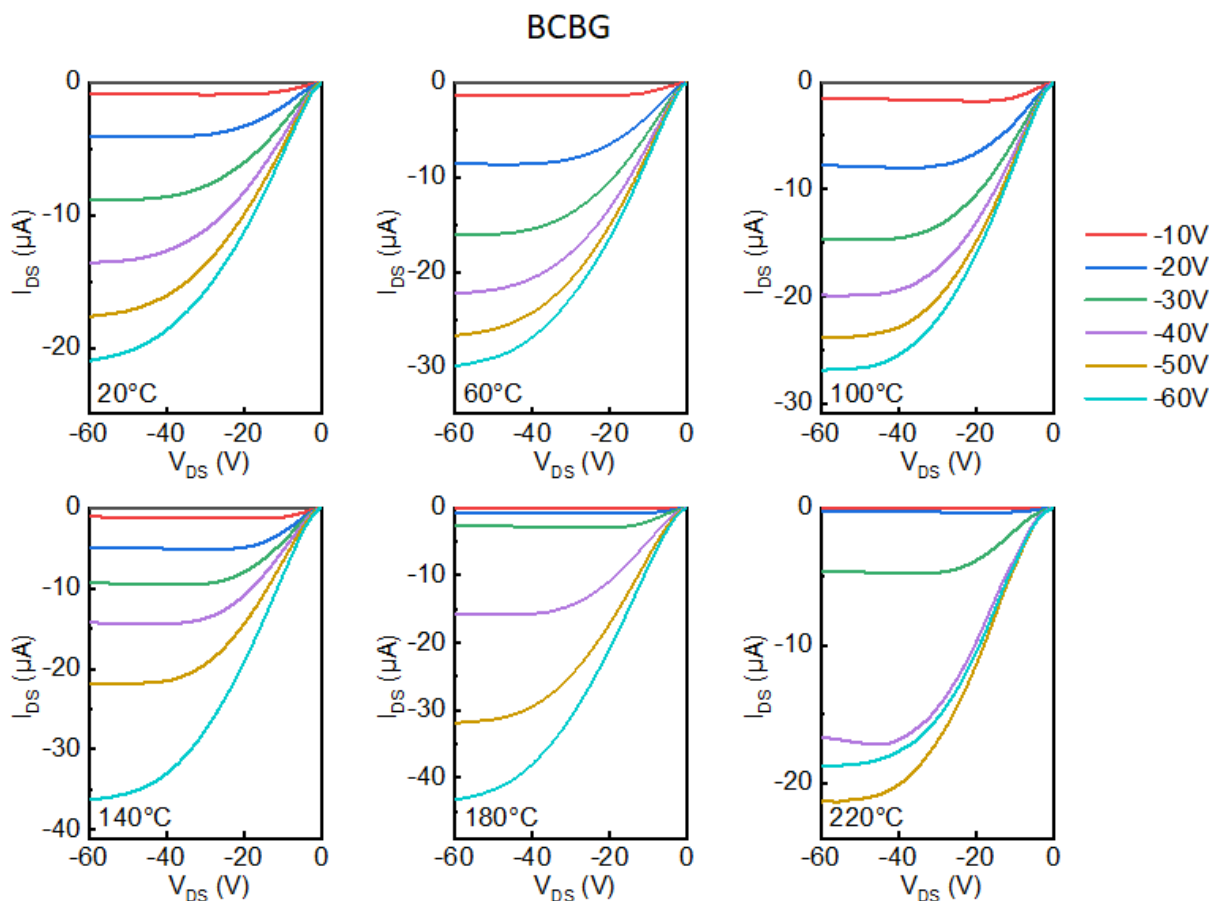


Figure S2: Output curves of BCBG IID-C1 devices from room temperature to 220°C. The output curve starts showing instability at 180°C with the reduction of low gate voltage current. At 220°C, the instability becomes more apparent, that the I_{DS} at $V_G = -60V$ is even smaller than that at $V_G = -50V$.

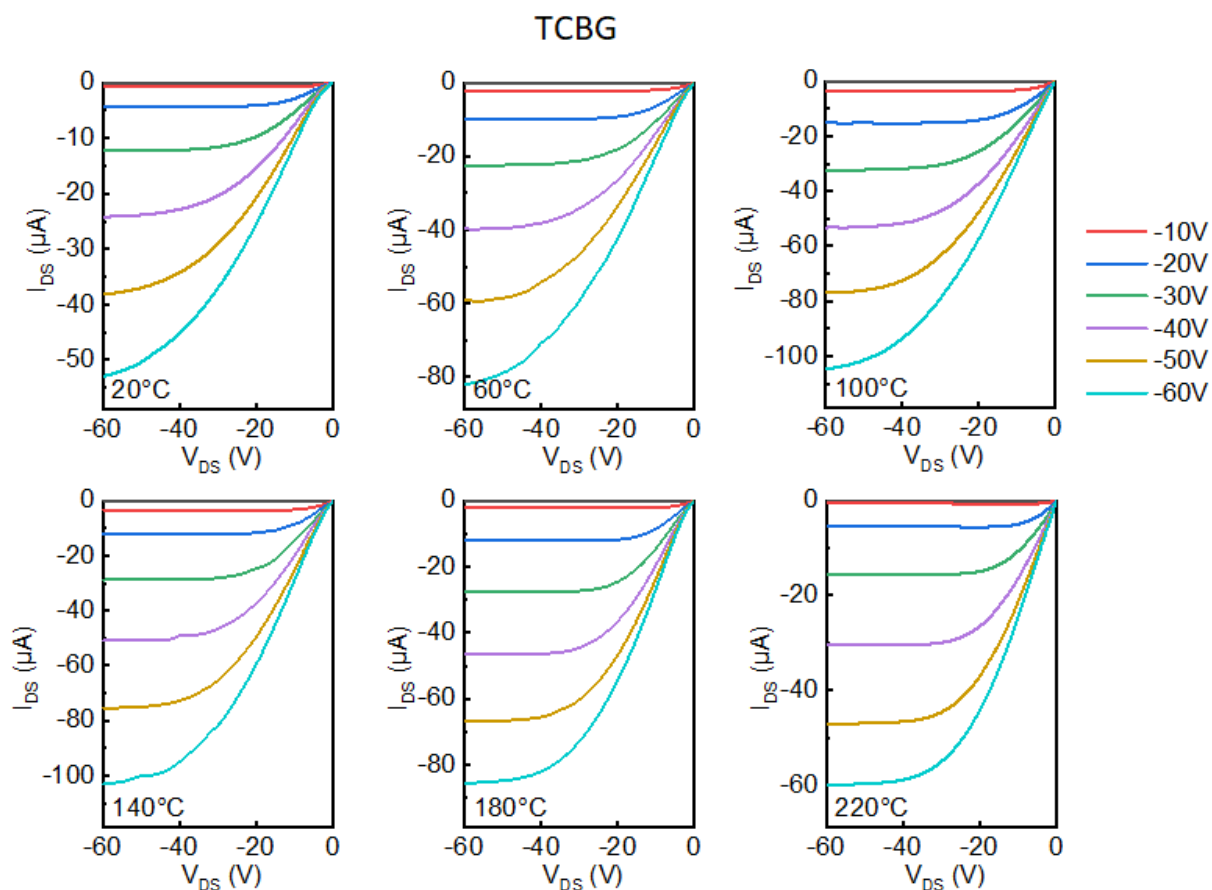


Figure S3: Output curves of TCBG IID-C1 devices from room temperature to 220°C. Even though the current starts to drop at 140°C, the output curves are ideal at all scanned temperature.

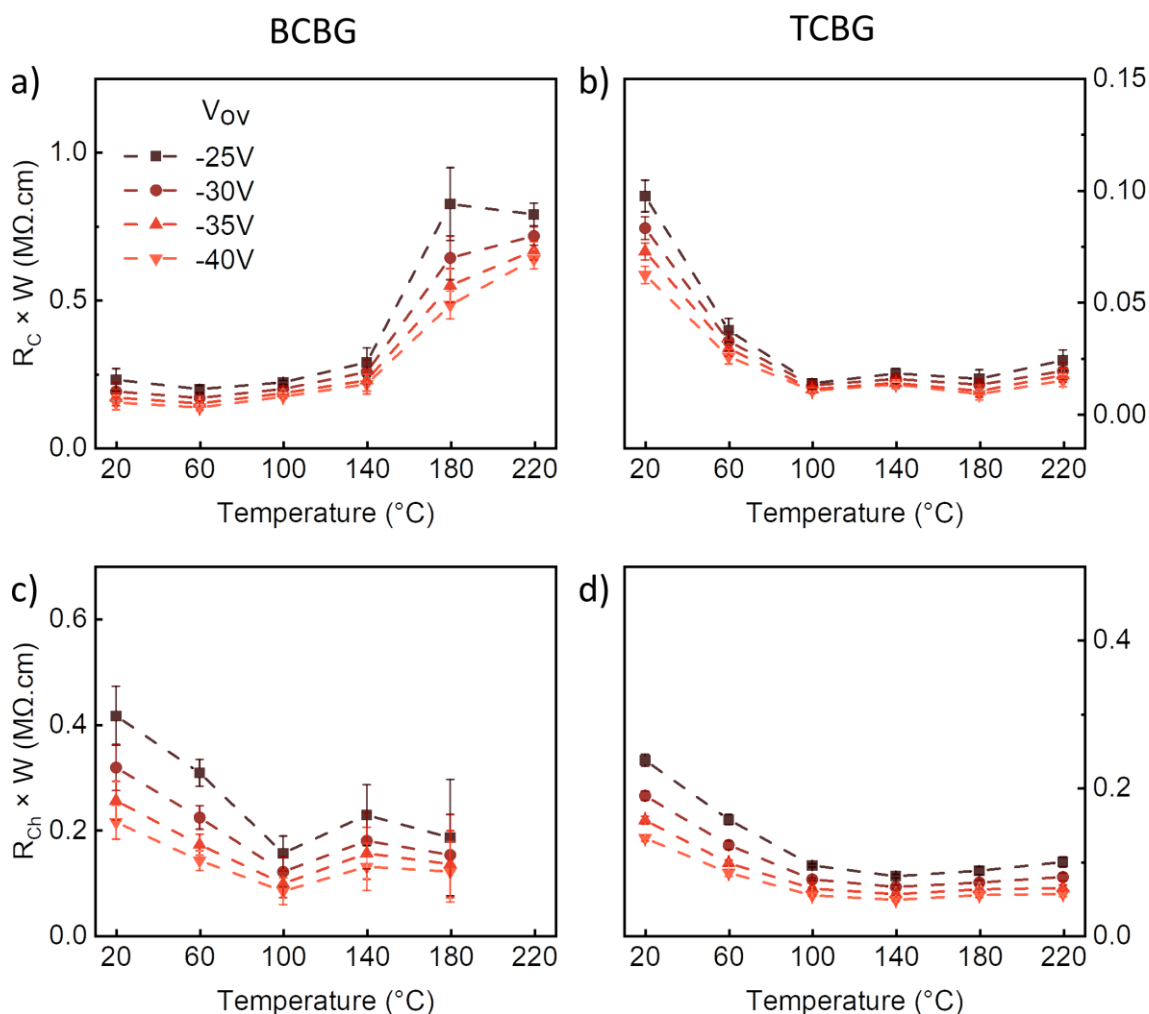


Figure S4: Temperature-dependent contact (a, b) and channel resistance (c, d) of BCBG and TCBG devices at different overdrive gate voltage ($V_{ov} = V_{GS} - V_T$). The contact resistance of BCBG suddenly increases at 180°C, more than one order of magnitude higher than that of TCBG. However, their channel resistance remains at a similar level at the whole scanned temperature range.

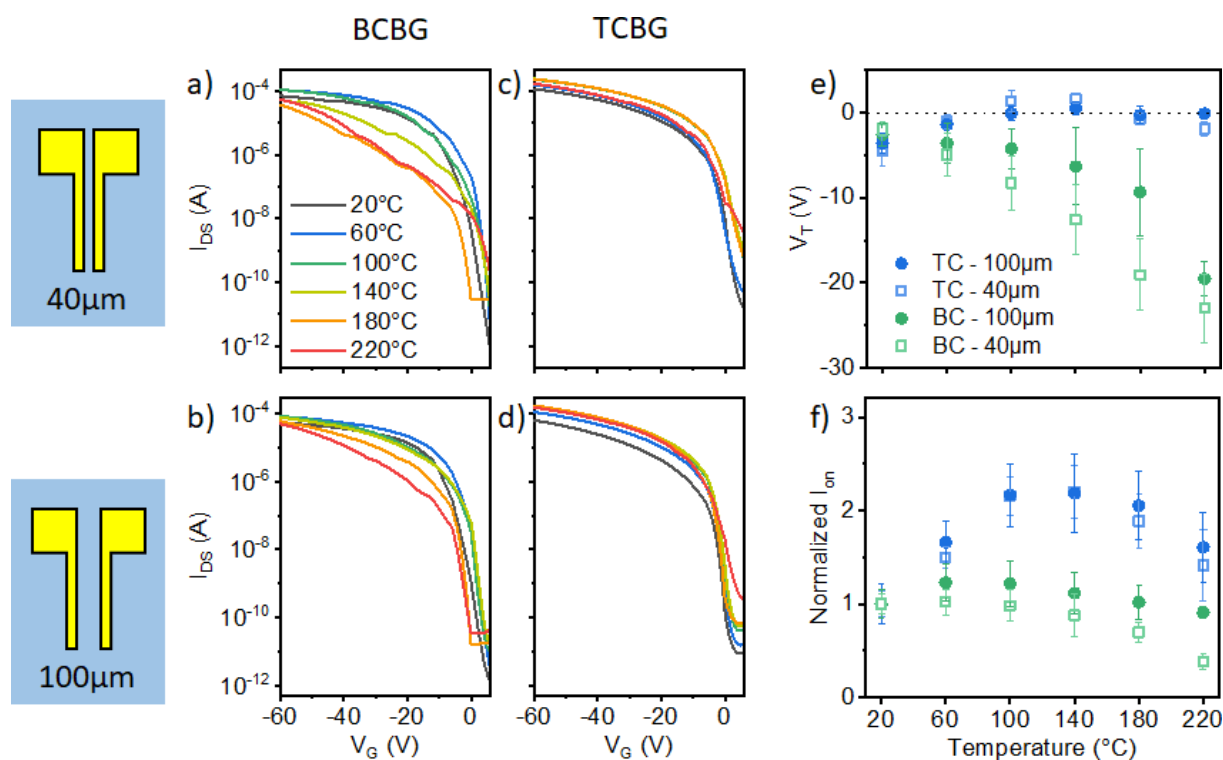


Figure S5: a-d) Typical temperature-dependent transfer characteristics of BCBG and TCBG devices with different channel lengths (40 μm , 100 μm); The temperature-dependent average threshold voltage (e) and normalized on-current (f) of two types of devices with two channel lengths. Generally, the device with longer channel length is more stable both in terms of on-current and threshold voltage. However, the BC devices, due to having significantly higher contact resistance, suffer more from this channel length effect.

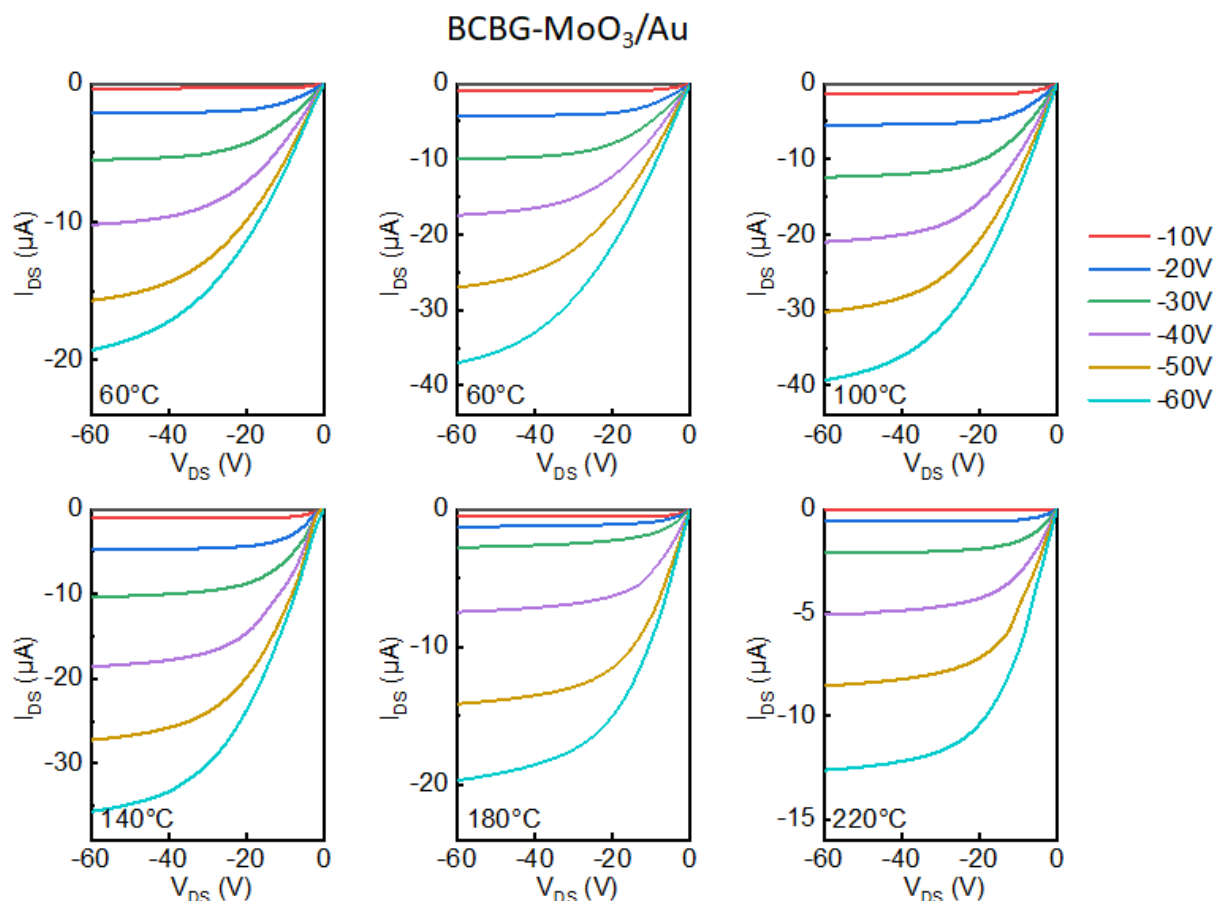


Figure S6: Output curves of BCBG IID-C1 devices with MoO₃ addition, are at ideal condition, from room temperature to 220°C.

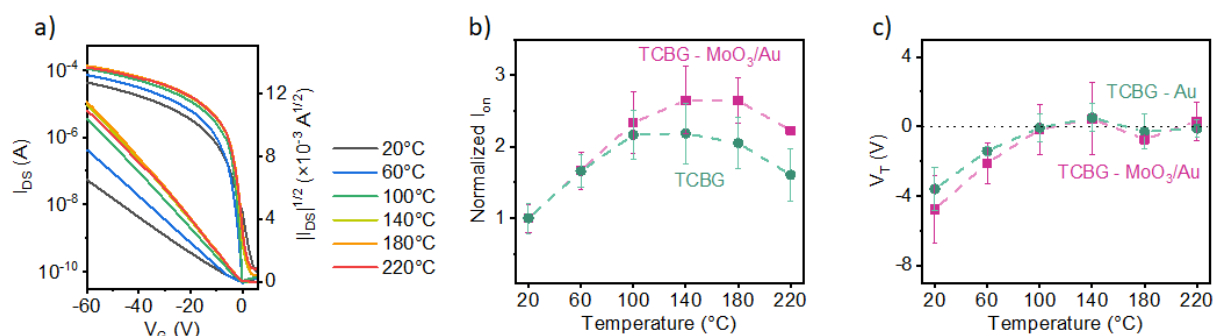


Figure S7: a) The typical temperature-dependent transfer characteristics of the TCBG OFET of IID-C1 with MoO₃ insertion layer; b) average temperature-dependent normalized on-current and c) threshold voltage of TCBG devices with bare Au electrode and MoO₃/Au electrode from 20°C to 220°C. With the MoO₃ injection layer, the on-current drops at a higher temperature, indicating a slight improvement in thermal stability.

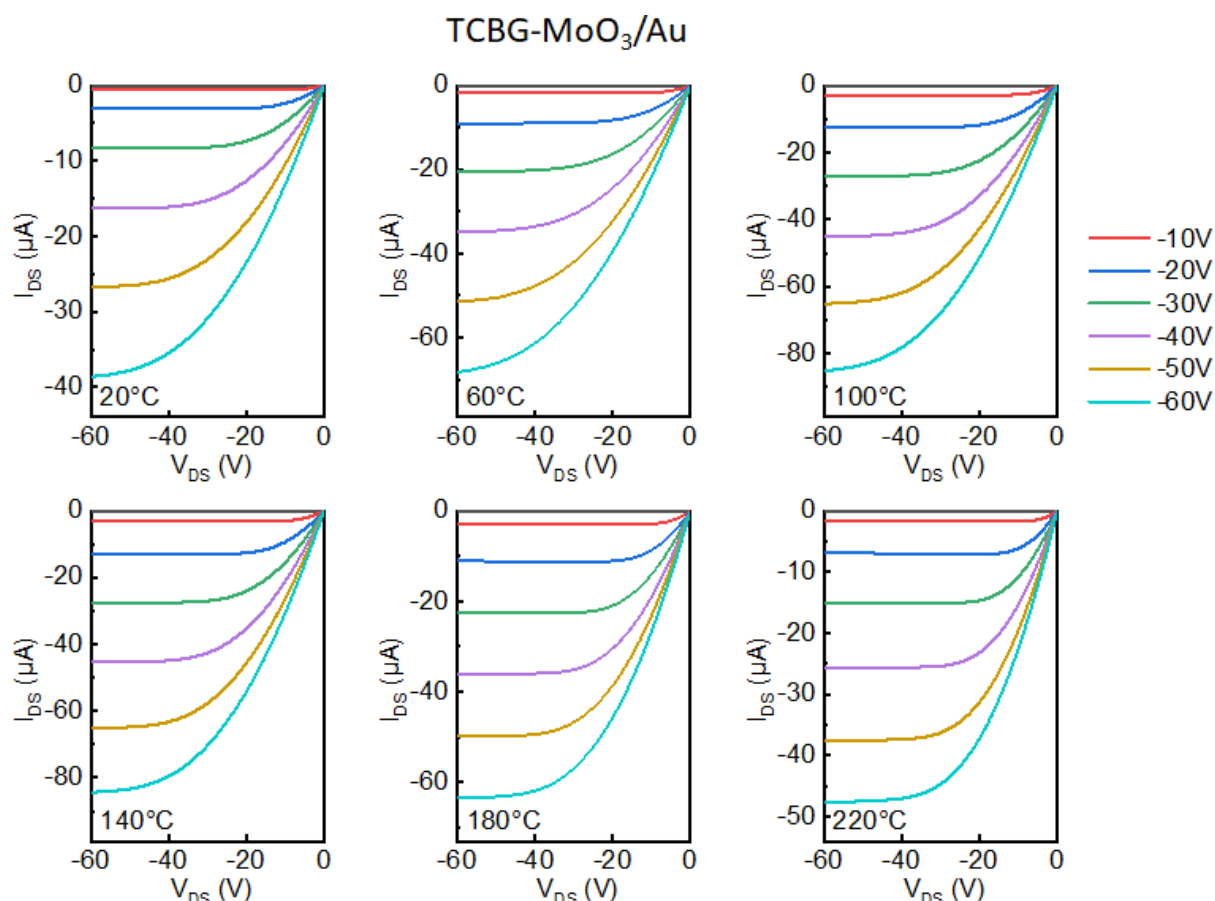


Figure S8: Output curves of TCBG IID-C1 devices with MoO₃ addition, from room temperature to 220°C.

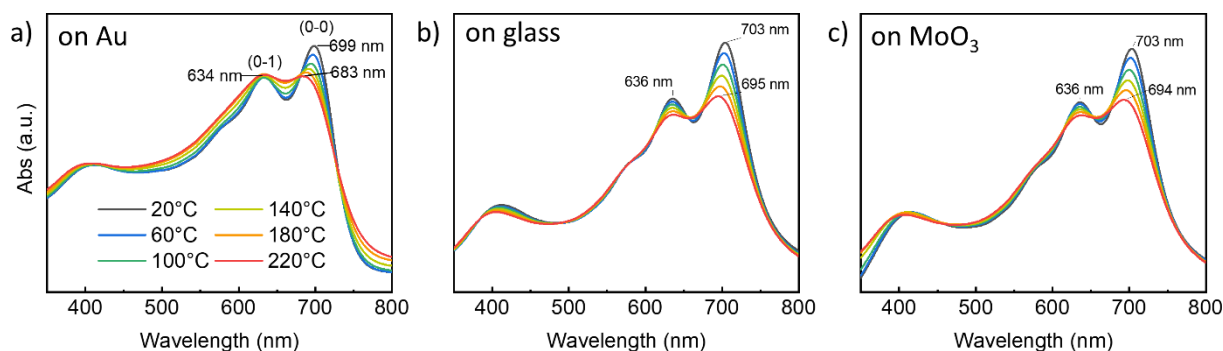


Figure S9: The temperature dependent UV-Vis absorption of IID-C1 thin film deposited on a) a thin layer of gold; b) a clean glass substrate; c) a layer of MoO₃. The film grown on two low-surface-energy surfaces glass and MoO₃ are very similar. On the other hand, the film deposited on gold metal is more blue-shifted at high temperature as well as have smaller A(0-0)/A(0-1), indicating this film is less planar and has worse polymer packing than the film on the other surfaces.

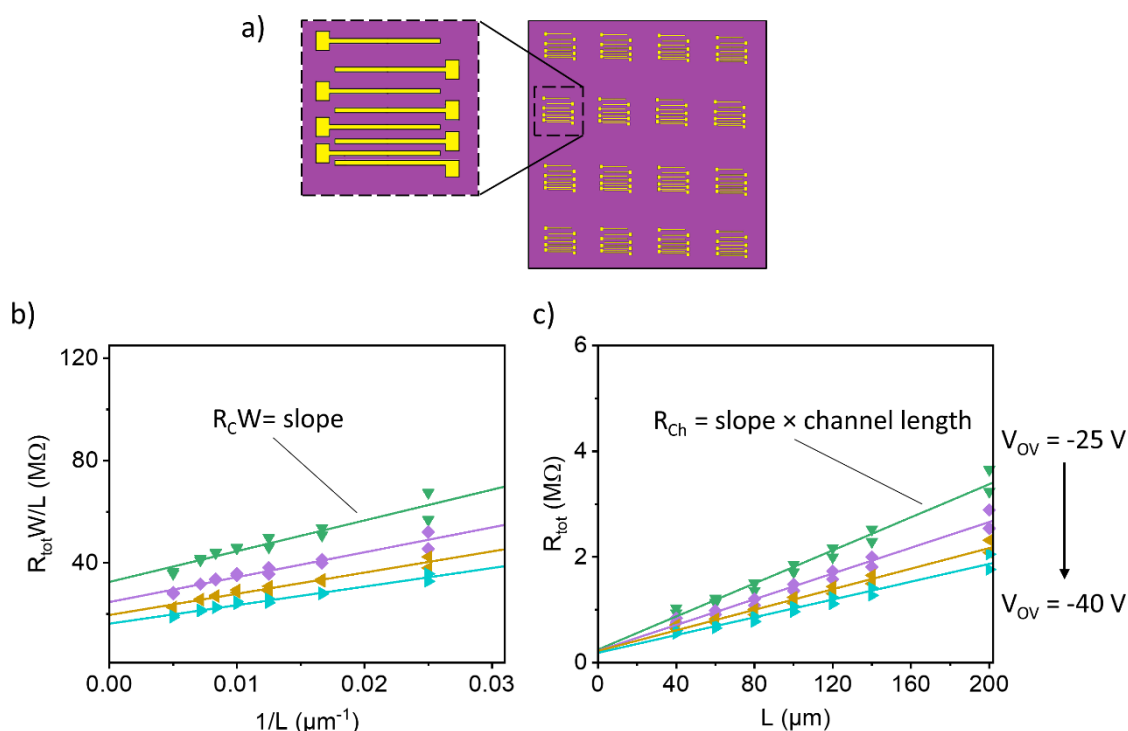


Figure S10: a) Schematic illustration of the electrode patterns for TLM measurements; b) A typical modified transmission-line-method fitting plot of IID-C1. The contact resistance is calculated from the slope of the fitting line; c) A typical transmission-line-method fitting plot. The channel resistance is calculated from the product of the slope of the fitting line and the channel length (100 μm).

References:

- (1) Choi, H. H.; Cho, K.; Frisbie, C. D.; Sirringhaus, H.; Podzorov, V. Critical Assessment of Charge Mobility Extraction in FETs. *Nat. Mater.* **2017**, *17* (1), 2–7.