# Solution-Processed Ambipolar Electrolyte-gated Field Effect Transistors from a $MoS_2$-polymer Hybrid for Multifunctional Optoelectronics

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## Support Information

**1. Scan electron microscopy (SEM) image of the few-layer $MoS_2$ nanosheets**

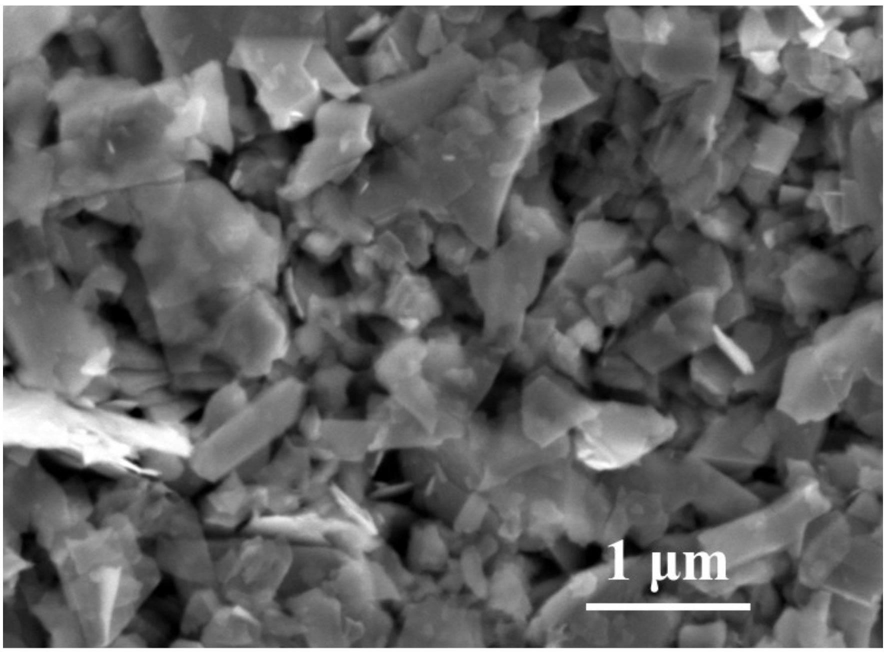


**Figure S1** The SEM image of the few-layer $MoS_2$ nanosheets from the solution-processed exfoliation method.

## 2. The EDL capacitance at the electrolyte/semiconductor interface

Impedance spectroscopy measurements were carried out to investigate the EDL capacitance of the amEGFET device by Hewlett Packard 4284A LCR meter. The source and drain electrodes were grounded while the gate electrode was connected to the anode of the LCR meter. DC voltage of 2 V and AC small signal 100 mV was applied onto the gate electrode.

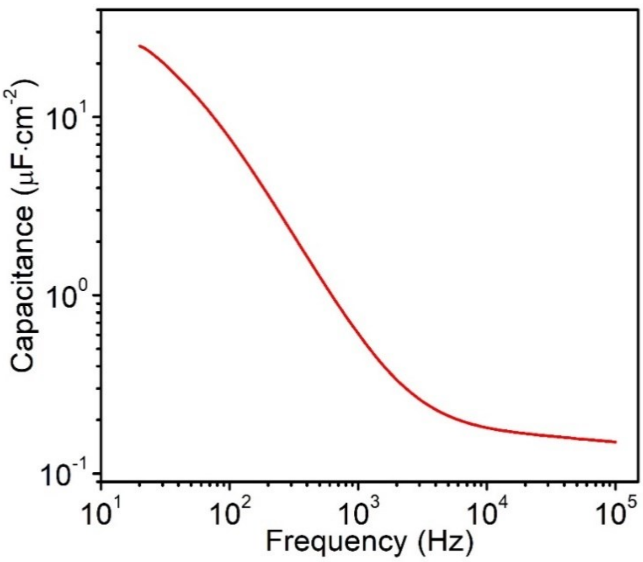


**Figure S2** The capacitance versus frequency at the electrolyte/semiconductor interface.

## 3. Dependence of the transfer characteristics on the sweep interval time

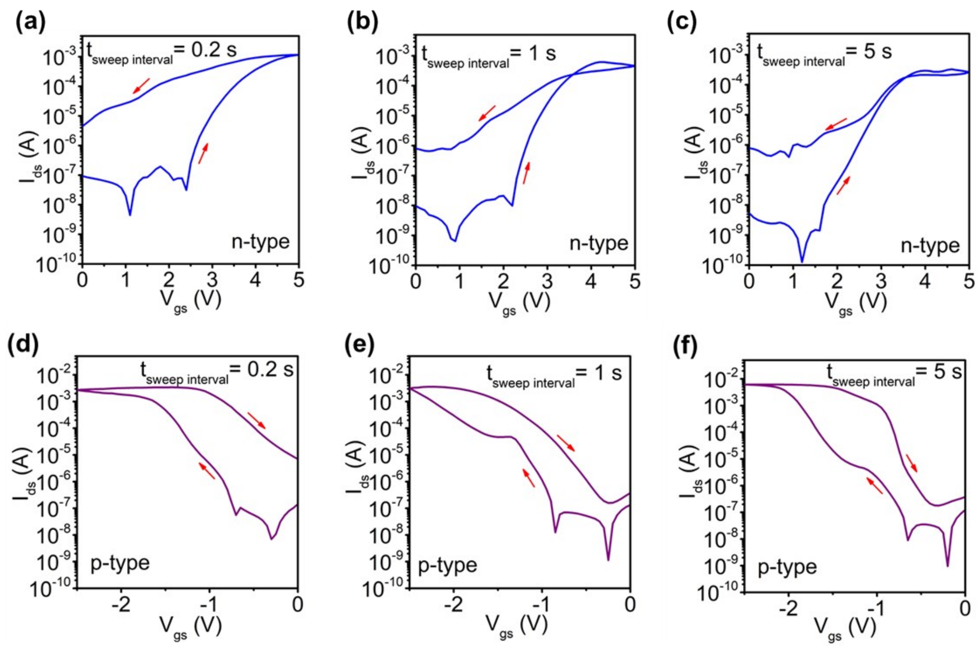


**Figure S3** Dependence of the (a-c) n-type and (d-f) p-type transfer characteristics on the sweep interval time ($t_{sweep\ interval}$).

## 4. Extraction of the field-effect mobilities

To extract the p-type and n-type field-effect mobilities, the work voltages of $V_{ds}$ = -0.3 V and $V_{gs}$= -2.5 V are set for hole while $V_{ds}$ = 0.3 V and $V_{gs}$= 4.0 V for electron. As shown in Figure 2c of the output characteristics, both the hole and electron work conditions are both approximatively in the linear region. Therefore, both hole and electron field-effect mobilities were extracted using a linear-region mobility equation:

$$\mu = \frac{L}{W \cdot V_{ds} \cdot C_i} \times \frac{\partial I_{ds}}{\partial V_{gs}} \quad \textbf{(1)}$$

where ***L*** is the channel length, ***W*** is the channel width, ***$V_{ds}$*** is the drain-source voltage ($V_{ds}$= -0.3 V for hole and $V_{ds}$=0.3 V for electron, respectively), ***$C_i$*** is the capacitance per unit area of the EDL layer, ***$I_{ds}$*** is the drain-source current, ***$V_{gs}$*** is the applied gate voltage.

## 5. Transfer characteristics of all 16 amEGFET samples

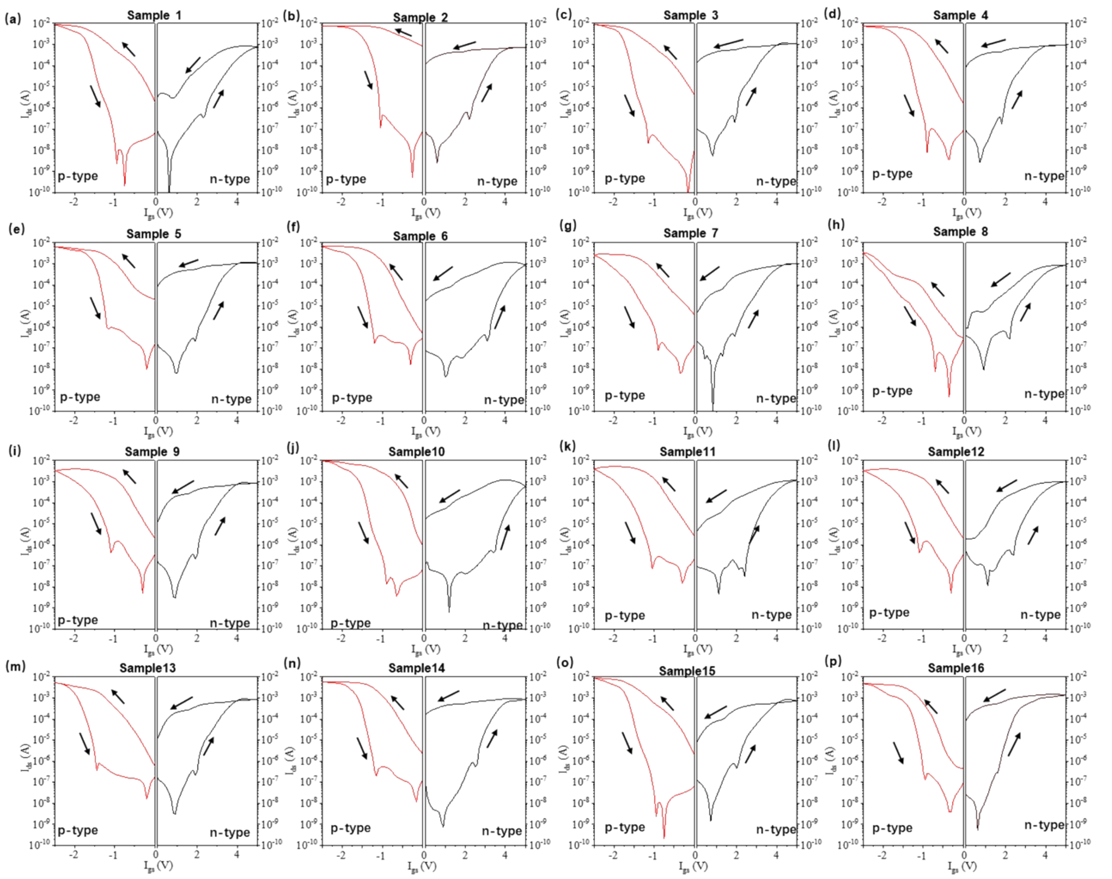


**Figure S4** The transfer characteristics of the all 16 amEGFET devices measured at room temperature in air.

## 6. The extract of the time constants of the rising and falling processes

The exponential relationships of $V_{op} \propto (1 - e^{1-\frac{t}{\tau_r}})$ and $V_{op} \propto e^{-\frac{t}{\tau_f}}$ were used to fit the rising and falling modulation response under different high levels of electrical input ($V_{HI}$), respectively, where $V_{op}$ is the optical output, $\tau_r$ is the time constant of the rising period and $\tau_f$ is the time constant of the falling period. The fitting results can be seen in Figure S5, where the blue and orange lines are the experimental and calculated data for optical output.

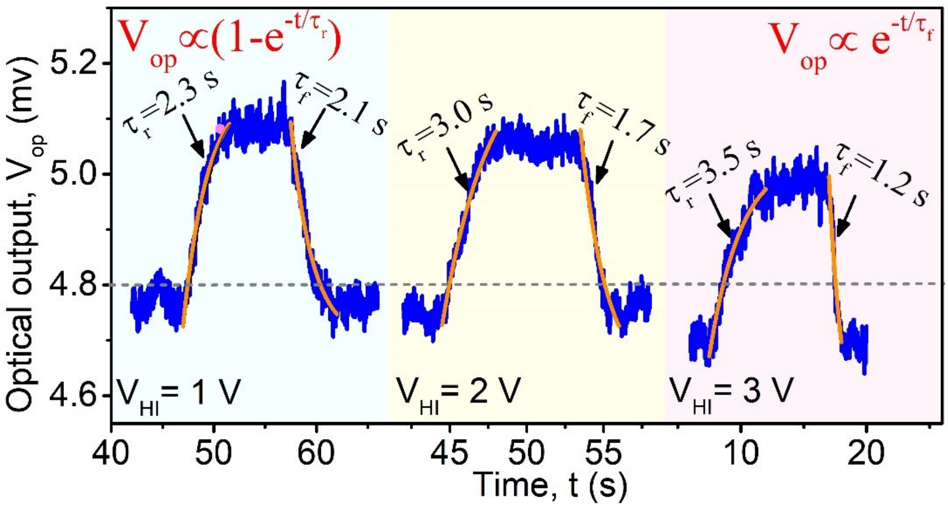


**Figure S5** Dependence of the time constant $\tau_r$ in a rising period and $\tau_f$ in a falling period on the high level of an electrical input ($V_{HI}$).