塗布成膜した還元型酸化グラフェン膜を用い縦た型有機トランジスタ

Vertical organic field-effect transistors using reduced solution-processed graphene oxide films

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Introduction: Vertical organic field effect transistors (VOFETs) with high current on/off ratio and easy fabrication process are highly desirable for future electronical applications. The graphene-based VOFETs have attracted considerable attention due to its gate-tunable Schottky barrier height at graphene-semiconductor heterojunctions. However, almost all these devices reported so far have utilized the monolayer graphene synthesized by chemical vapor deposition (CVD) method. Although this method can achieve high quality single-layer graphene, the complicated transfer process of graphene to the target substrate has severely limited its large-scale applications. Recently, we developed a promising method to prepare ultrathin reduced graphene oxide (rGO) film by spin coating graphene oxide (GO) dispersion [1], which could be effectively applied as a work function tunable electrode in VOFETs.

Experimental section: The highly purified graphene oxide dispersion was firstly spin-coated on a n-doped Si/SiO_2 wafer, followed by chemical and thermal reduction to obtain the rGO layer. Then PTCDI-C_8 and Al were subsequently deposited on the patterned rGO through a shadow mask using vacuum deposition equipment and the final device rGO-VOFETs was fabricated (Fig 1a).

Results and discussion: In the output characteristics (Fig 1b), drain current (I_D) increases as gate voltage (V_G) increases positively, indicating it is a typically n-channel transistor. The asymmetric rectifying behavior is observed at opposite side of drain voltage (V_D), with larger current modulation at positive side of V_D than that at negative side. It could be attributed to the gate-tunable injection barrier at rGO/PTCDI-C_8 interface. In the transfer characteristics (Fig 1c), both the drain current and gate leakage current (I_{gate}) increase with the increases of V_D, however, I_D increases more rapidly compared to that of I_{gate}, generating the highest current on/off ratio exceeding 10^4. The maximum current density is 1.42 mA/cm^2 at V_D = + 5 V and V_G = + 40 V. The use of a simple solution-processable rGO as work function tunable electrode in VOFETs opens up a new opportunity for future large-scale application in organic electronics.

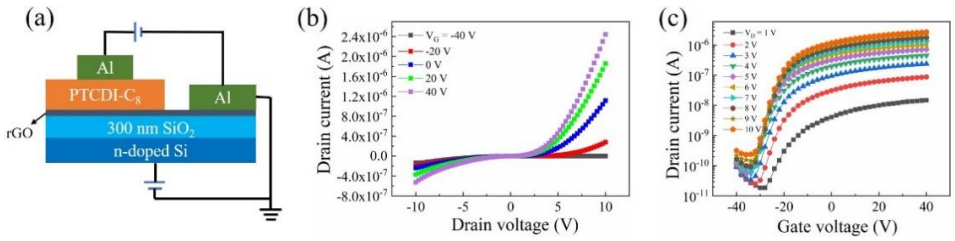

Fig 1. (a) Cross-sectional schematical illustration of the device. (b) Output and characteristics of the device. (c) Transfer characteristics of the device.

[1] K. Yamada, K. Nakayama et al., *RSC Adv.*, **9**, 32940 (2019)