Electronic Supplementary Material (ESI) for RSC Advances.

Supporting Information

Direct transfer of graphene and the application in low-voltage hybrid transistors

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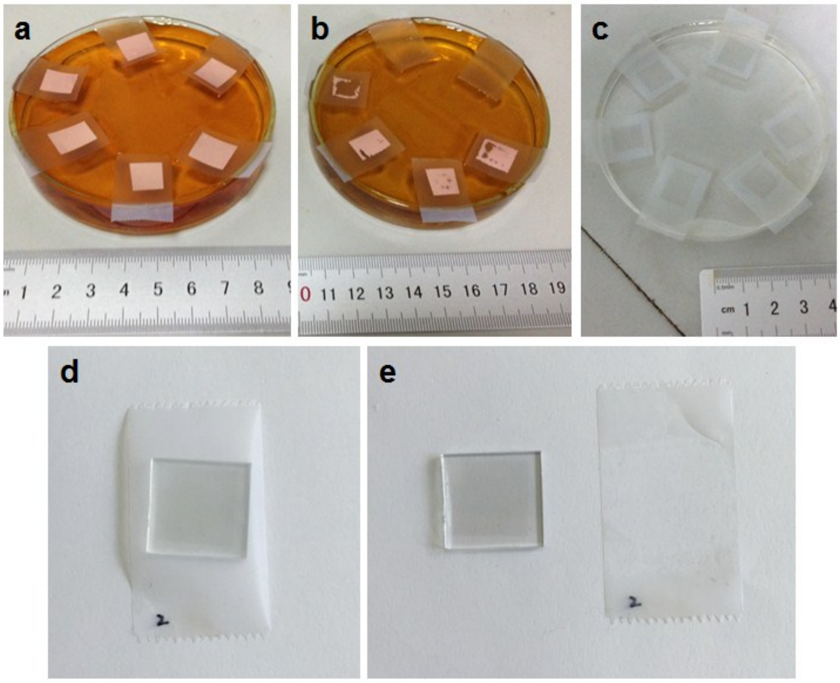

Figure S1. The photographs of scotch tape assisted direct transfer of CVD-graphene process.

The assumed mechanism for transfer of graphene via scotch tape.

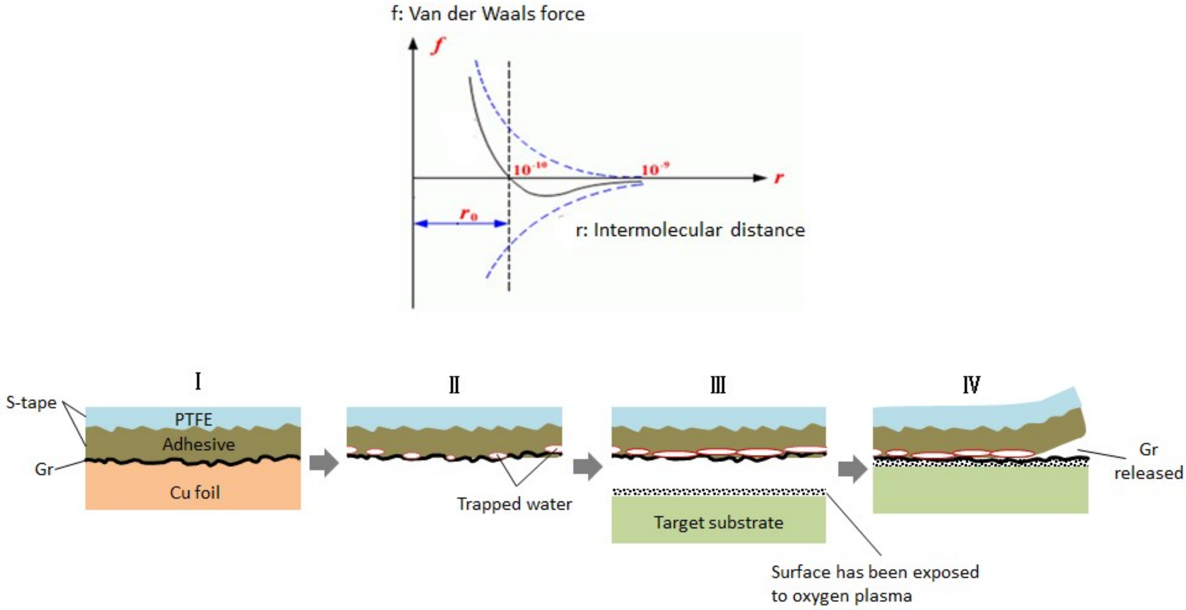

Figure S2. Transfer process for the graphene from Cu foil to target substrate. S-tape is short for scotch tape, PTFE for Polytetrafluoroethene, Gr for graphene.

The most acceptable reason why tapes can adhere to objects is mainly due to the Van der Waals force. Tapes are usually composed of two parts. One is the base material such as PTFE (Polytetrafluoroethene), BOPP (Biaxially-oriented Polypropylene) et al. The other is the adhesive. Based on the experimental phenomena, we assumed that the transfer for CVD graphene from original Cu foil to target substrate via scotch tape went through four stages, schematically shown in Figure S2.

First, when scotch tape attached with Gr/Cu, the adhesive would fill the uneven surface of Gr/Cu (also called the wetting process), decreasing the intermolecular distance between tape and graphene. Thus the Van der Waals force could function to stick them together. In addition, the dangling hydrogen bond of the adhesive also contributed to the attachment.

Second, during Cu etching, it is noted that water molecules diffused into the interface between the tape and graphene. This led to the saturation of hydrogen bonds on the tape, and the increase of the intermolecular distance between tape and graphene. Therefore, the adhesive force of the tape was significantly weakened.

Third, the target substrate was exposed to oxgyen plasma prior to use, which engendered high surface energy and dangling hydrogen bond on the target substrate surface. Finally, when the tape/water/graphene sandwich structure was in contact with the treated target substrate, the graphene that was weakly adherent to the tape could be easily released onto the target substrate.

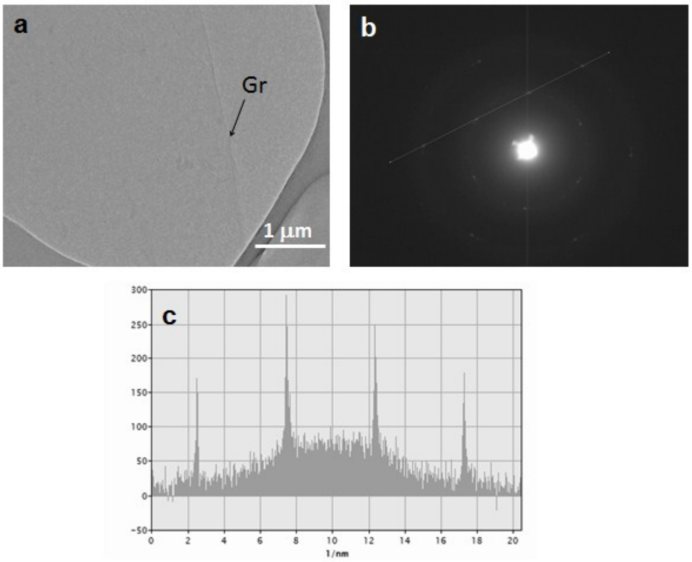

Figure S3. (a) TEM image of scotch tape transferred graphene. (b) SAED pattern from the graphene. (c) Intensity profile over the $\{11\bar{2}0\}$ (outer) and $\{10\bar{1}0\}$ (inner) spots from the SAED pattern, confirming monolayer graphene.

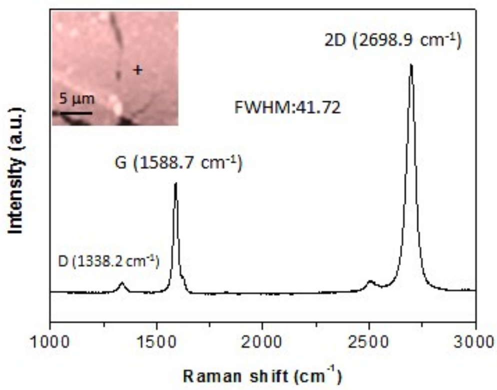

Figure S4. Raman spectrum of graphene on SiO_2/Si transferred by PMMA method.

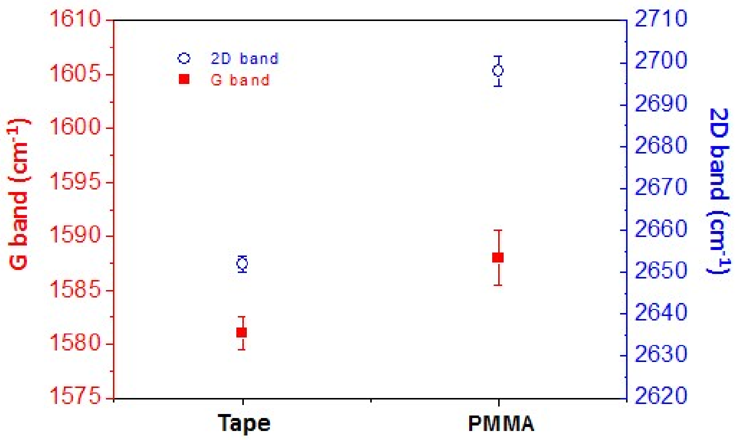

Figure S5. G and 2D band shift of graphene, indicating that the scotch tape transferred graphene is much less doped.

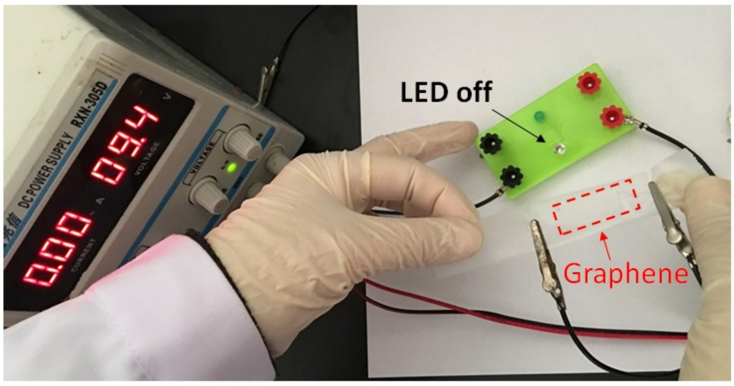

Figure S6. Tape in while graphene out of the circuit, LED kept off, suggesting that the tape substrate is elecinsulating.

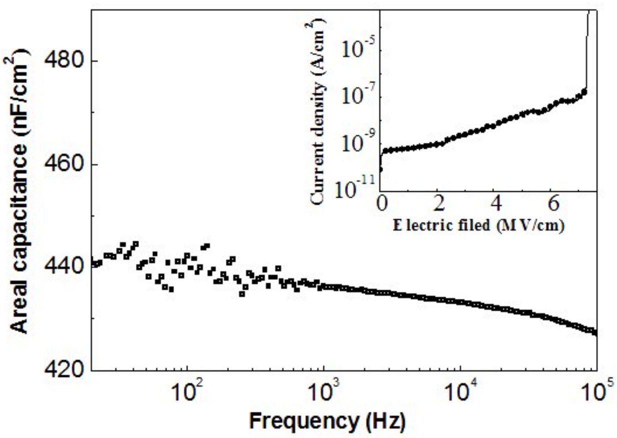

Figure S7. Areal capacitance of an Al/ZrO_2/p^+-Si capacitor as a function of the frequency. The inset shows the leakage-current density versus electric field.

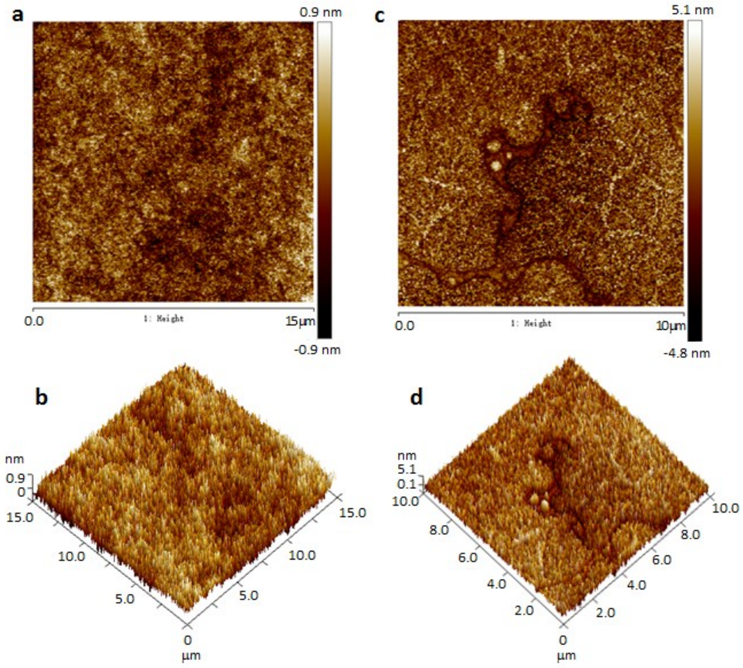

Figure S8. The AFM images of as-deposited ZrO_2 dielectric film (a, b) before and (c, d) after acetone bath for 5 h.