

## Supporting Information

### **Stabilization of Hybrid Perovskite $\text{CH}_3\text{NH}_3\text{PbI}_3$ Thin Films by Graphene Passivation**

*Wei-Shiuan Tseng,<sup>a,b</sup> Meng-Huan Jao,<sup>a,c</sup> Chen-Chih Hsu,<sup>a</sup> Jing-Shun Huang,<sup>d</sup> Chih-I Wu,<sup>b</sup> and N.-C. Yeh<sup>\*,a</sup>*

<sup>a</sup>Department of Physics, California Institute of Technology, Pasadena, CA 91125, USA

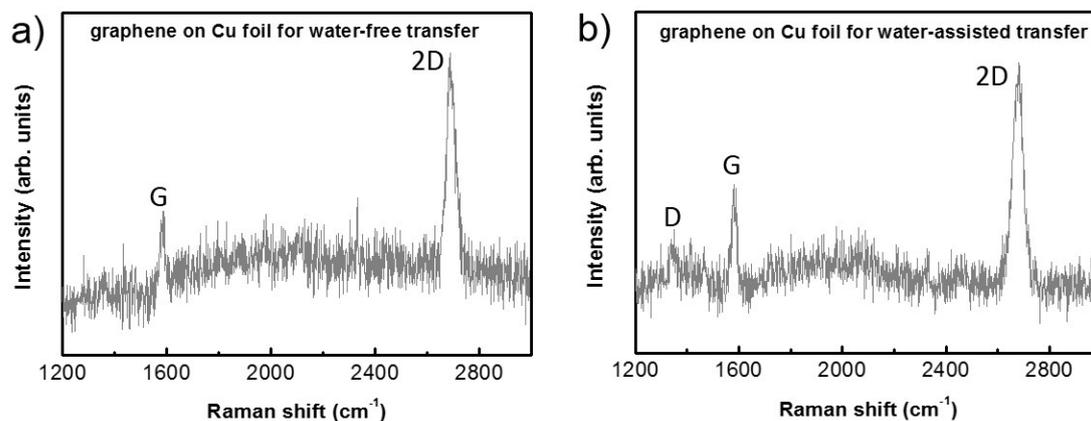
<sup>b</sup>Graduate Institute of Photonics and Optoelectronics and Department of Electrical Engineering, National Taiwan University, Taipei 106, Taiwan

<sup>c</sup>Department of Materials Science and Engineering, National Taiwan University, Taipei 106, Taiwan

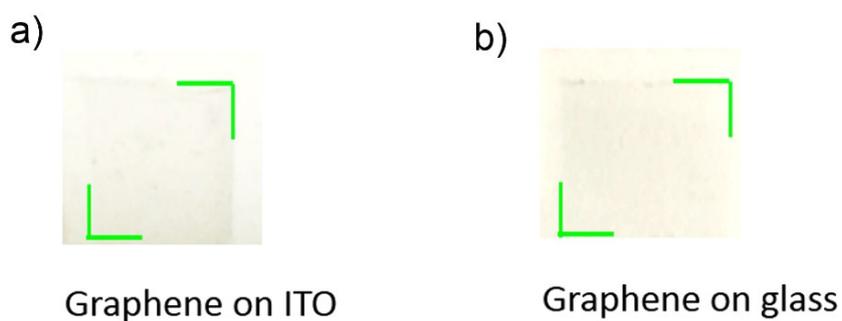
<sup>d</sup>Tomas J. Watson Laboratories of Applied Physics, CA 91125, USA

\*E-mail: Nai-Chang Yeh (ncyeh@caltech.edu)

## Supporting figures:

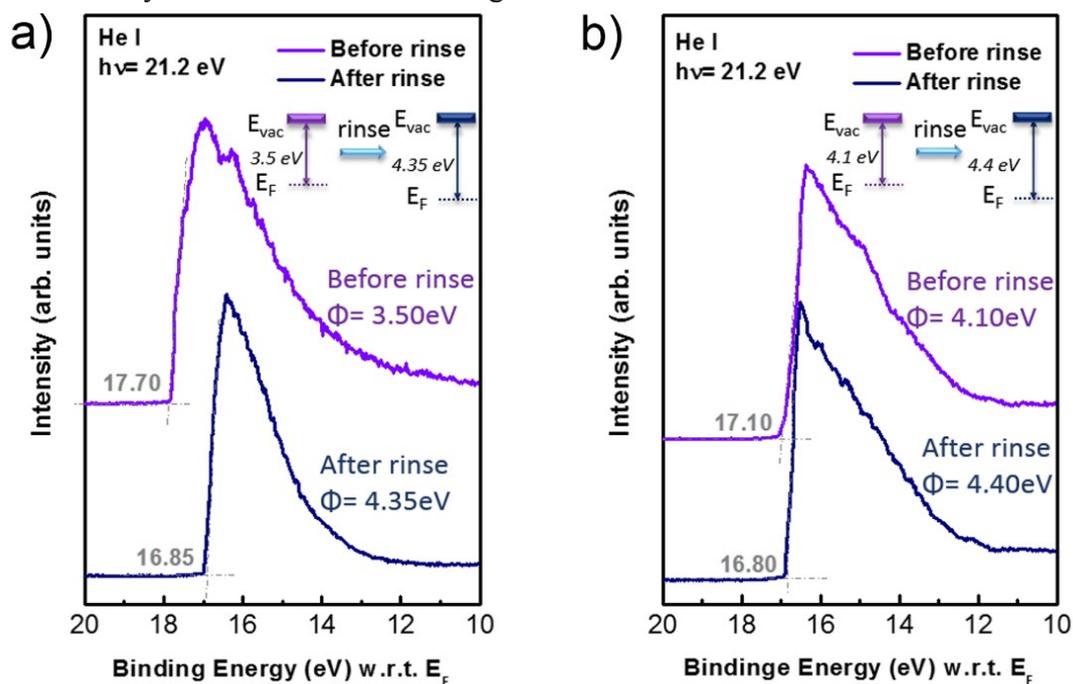


**Figure S1.** Raman spectra of the same graphene samples as shown in Figure 1 before the removal of their Cu substrate: (a) As-grown graphene on Cu before the water-free transfer; and (b) as-grown graphene on Cu before the water-assisted polymer-free transferring.

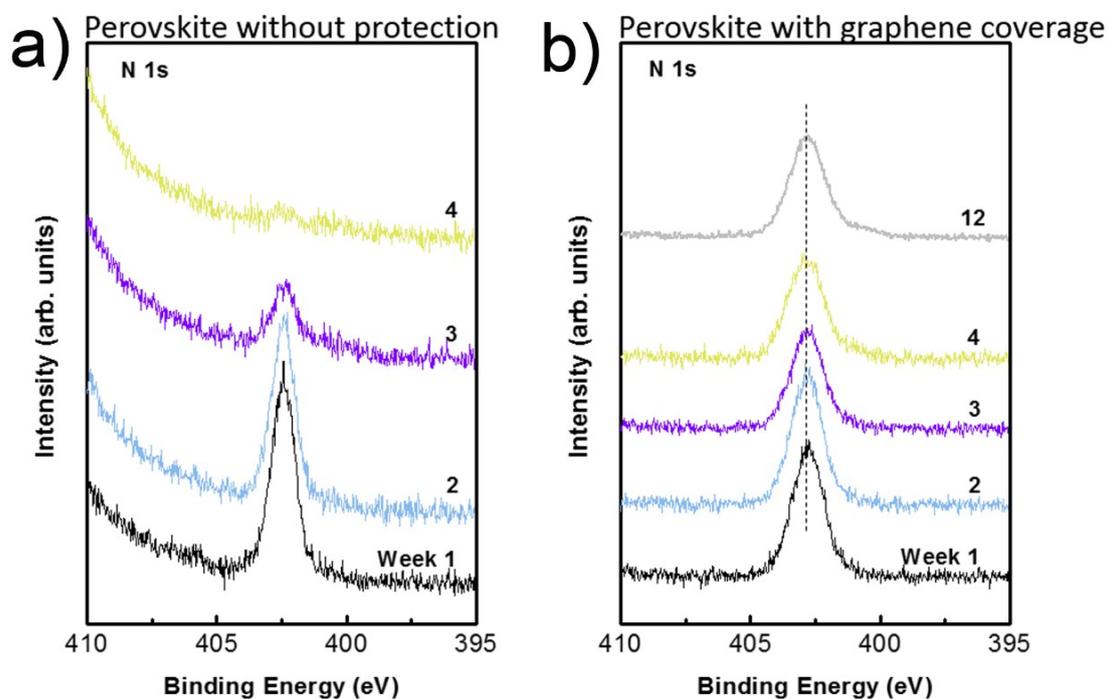


**Figure S2.** Optical micrographs of graphene sheets on (a) ITO and (b) glass surfaces

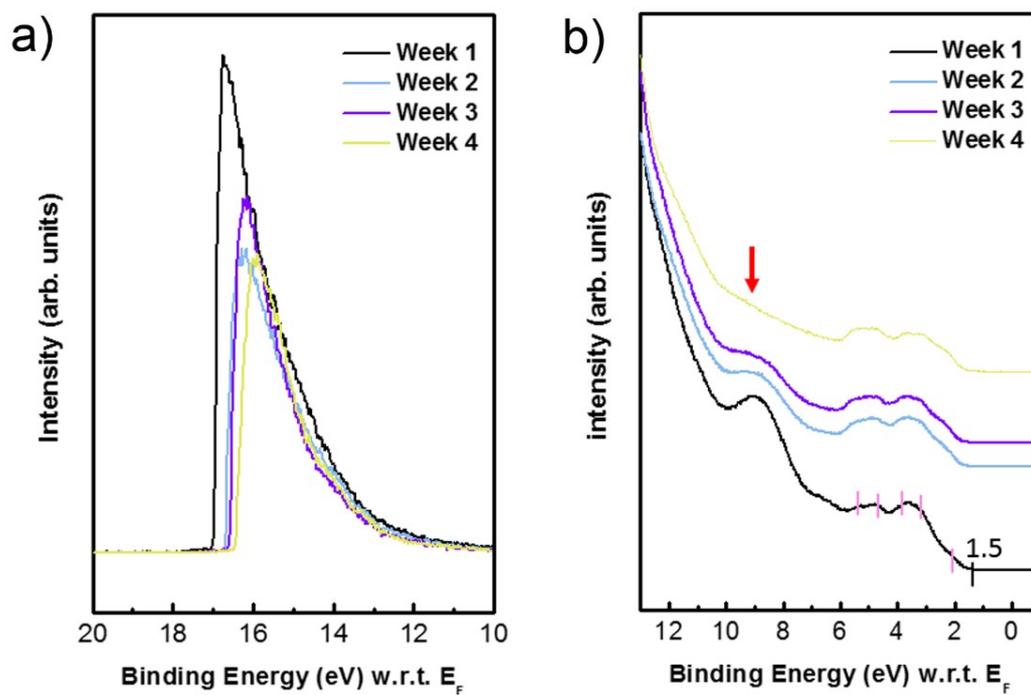
transferred by the water-free transferring method.



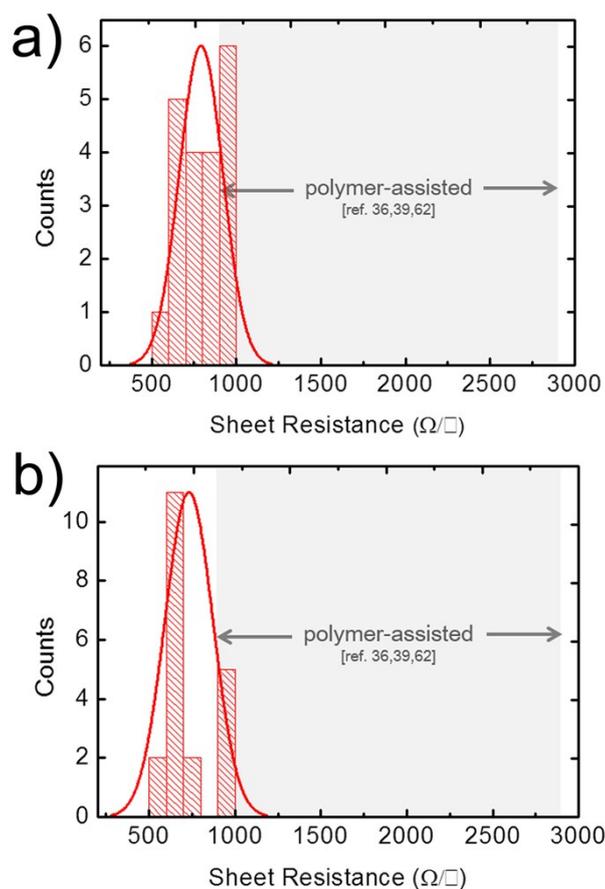
**Figure S3.** The work functions of as-transferred graphene measured via UPS. (a) UPS data of graphene transferred with the water-free method before and after rinse. (b) UPS data of graphene transferred with the water-assisted method before and after rinse.



**Figure S4.** Evolution of XPS N-1s peaks as a function of ambient storage time. (a) Perovskite surface without any protection. (b) Perovskite with graphene covered.



**Figure S5.** Evolution of perovskite degradation monitored via high-resolution UPS without graphene protection. (a) The evolution of secondary electron cutoff as a function of aging time. (b) The evolution of high-resolution valence band UPS spectra.



**Figure S6.** Statistics of the sheet resistance of graphene transferred onto  $a$ -SiO<sub>2</sub> by both (a) water-free and (b) water-assisted methods, showing values very close to the typical sheet resistance of graphene that was transferred by other polymer-free methods but much lower than those of the PMMA-transferred graphene samples indicated in the shaded band. Here the sheet resistance measurements were carried out on 20 different areas of each sample.