

Supporting Information

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

Wei-Shiuan Tseng,^{a,b} Meng-Huan Jao,^{a,c} Chen-Chih Hsu,^a Jing-Shun Huang,^d Chih-I Wu,^b and N.-C. Yeh^{,a}*

^aDepartment of Physics, California Institute of Technology, Pasadena, CA 91125, USA

^bGraduate Institute of Photonics and Optoelectronics and Department of Electrical Engineering, National Taiwan University, Taipei 106, Taiwan

^cDepartment of Materials Science and Engineering, National Taiwan University, Taipei 106, Taiwan

^dTomas J. Watson Laboratories of Applied Physics, CA 91125, USA

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

Supporting figures:

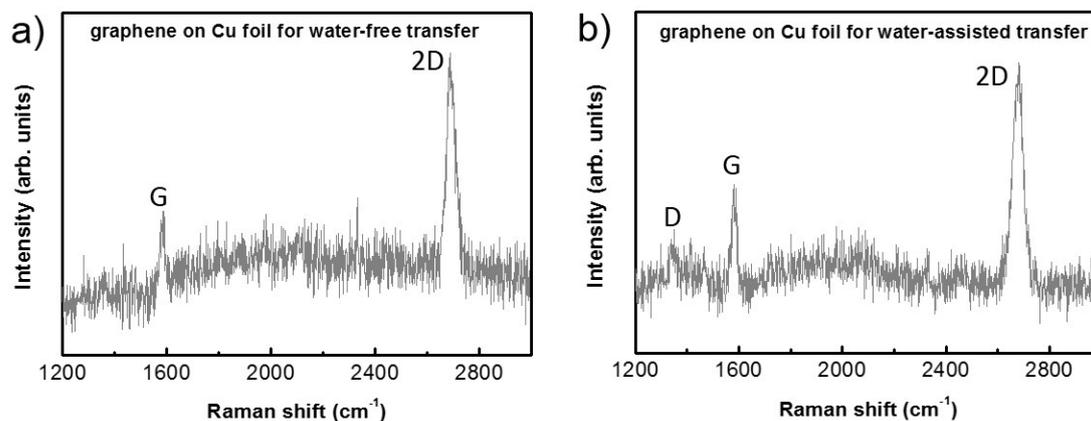


Figure S1. Raman spectra of the same graphene samples as shown in Figure 1 before the removal of their Cu substrate: (a) As-grown graphene on Cu before the water-free transfer; and (b) as-grown graphene on Cu before the water-assisted polymer-free transferring.

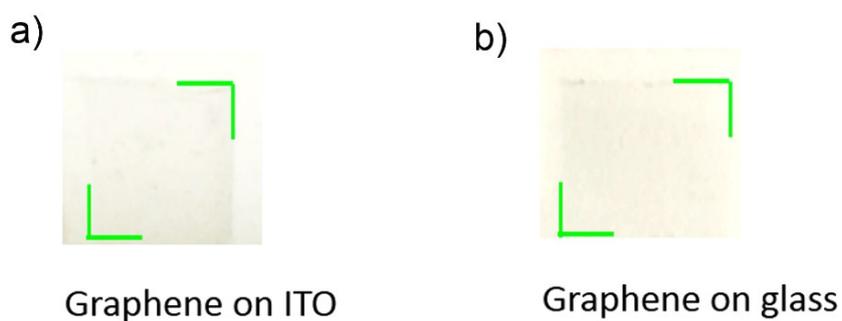


Figure S2. Optical micrographs of graphene sheets on (a) ITO and (b) glass surfaces

transferred by the water-free transferring method.

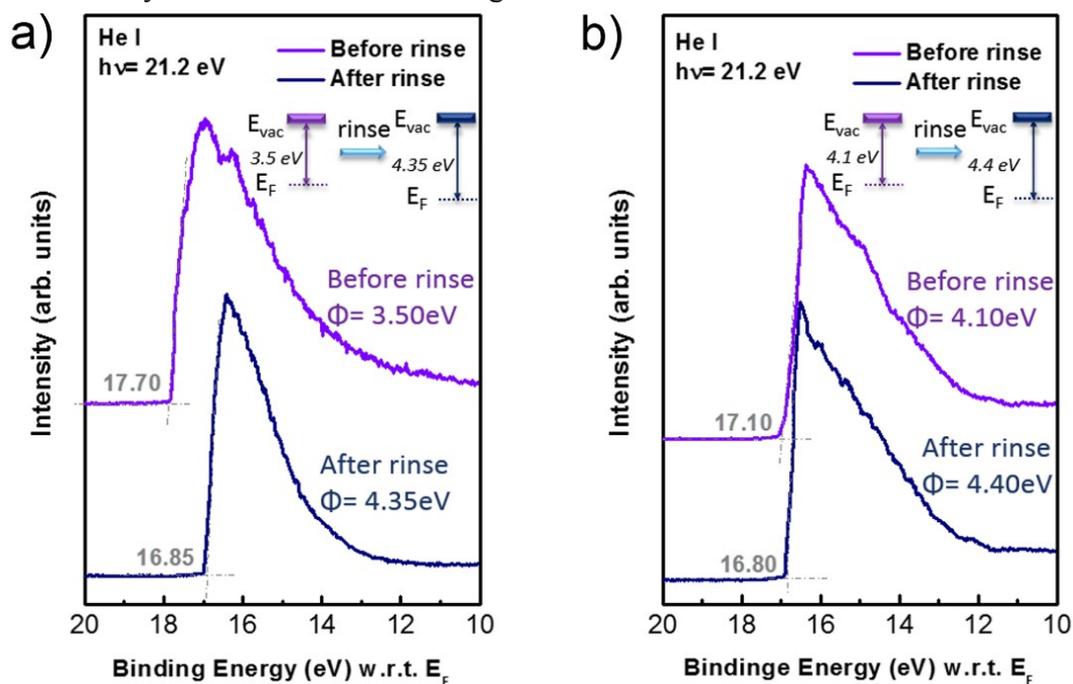


Figure S3. The work functions of as-transferred graphene measured via UPS. (a) UPS data of graphene transferred with the water-free method before and after rinse. (b) UPS data of graphene transferred with the water-assisted method before and after rinse.

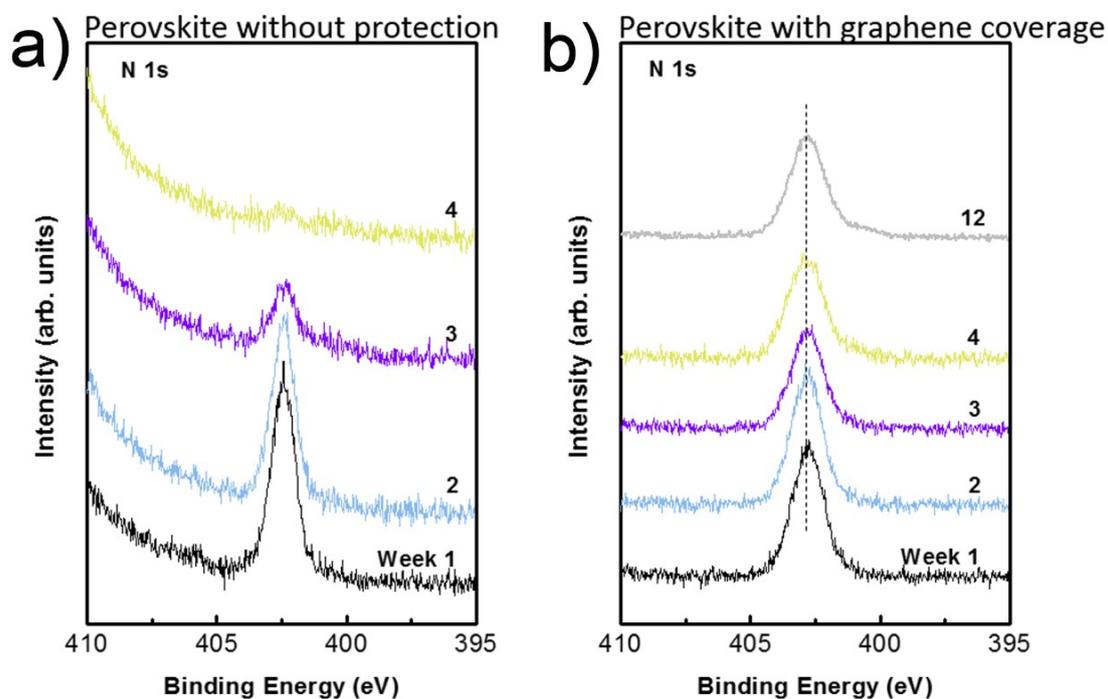


Figure S4. Evolution of XPS N-1s peaks as a function of ambient storage time. (a) Perovskite surface without any protection. (b) Perovskite with graphene covered.

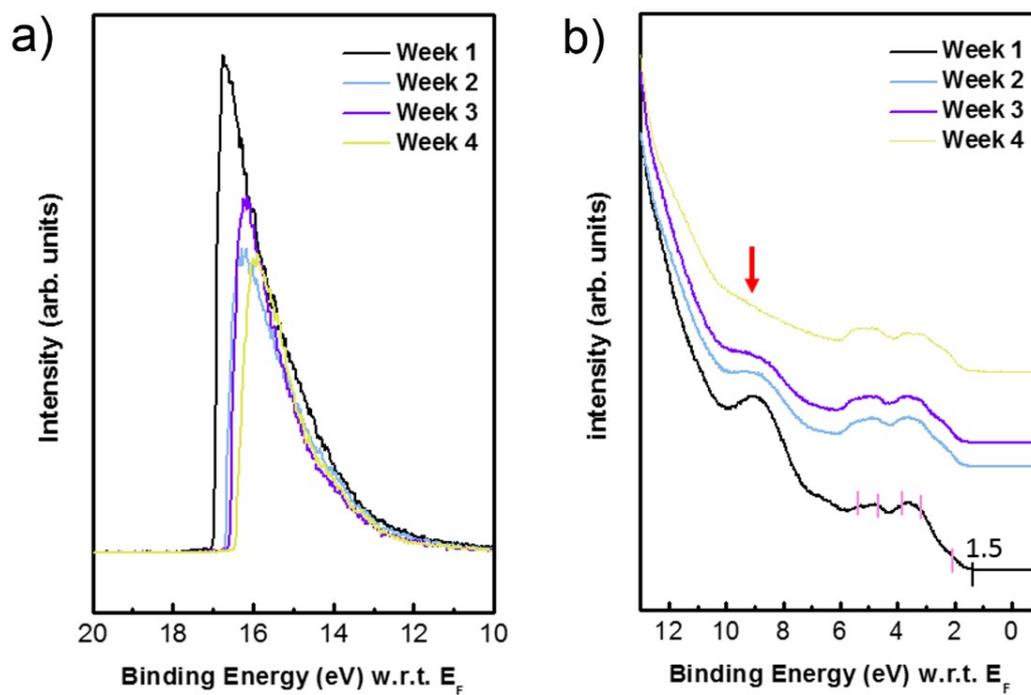


Figure S5. Evolution of perovskite degradation monitored via high-resolution UPS without graphene protection. (a) The evolution of secondary electron cutoff as a function of aging time. (b) The evolution of high-resolution valence band UPS spectra.

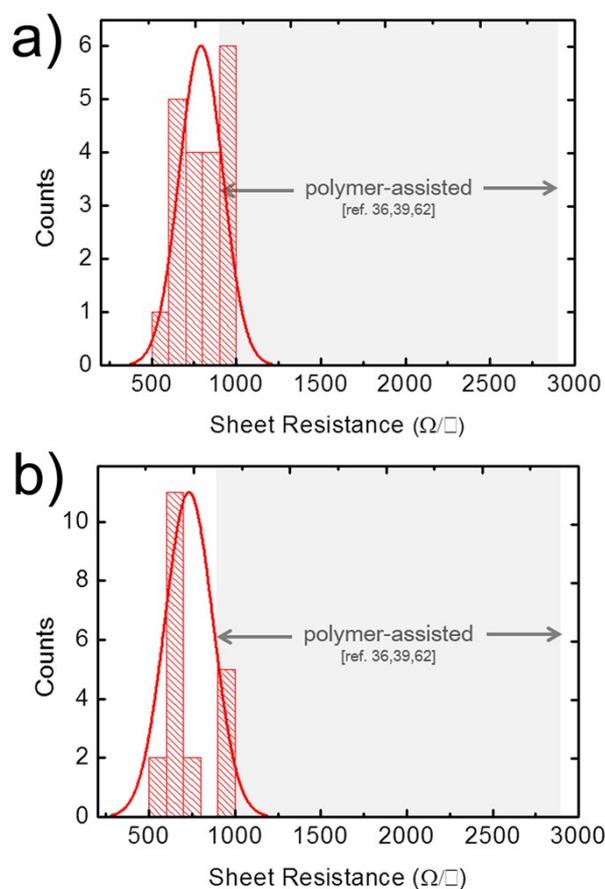


Figure S6. Statistics of the sheet resistance of graphene transferred onto $a\text{-SiO}_2$ by both (a) water-free and (b) water-assisted methods, showing values very close to the typical sheet resistance of graphene that was transferred by other polymer-free methods but much lower than those of the PMMA-transferred graphene samples indicated in the shaded band. Here the sheet resistance measurements were carried out on 20 different areas of each sample.