Hydrogen isotopes functionalization of nano-porous graphene: attainment of stable and low-defect free-standing *graphane*

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Achievement of semiconducting *graphane* [1] through hydrogen isotopes adsorption on semi-metallic graphene is a big challenge in terms of the quality and stability of the hosting graphene. High quality and low-defect free-standing nano porous graphene (NPG), synthetized by a nano-porous Ni based chemical vapour deposition (CVD) method [2], is an outstanding hosting graphene template for enhancing the loading of hydrogen (H) stable isotopes due to its large surface to volume ratio [3] and the absence of any holding substrate.

We here with present achievement of H- and deuterium- (D) free-standing *graphane* based on low-energy ion irradiation (6 eV) and hot-temperature cracked molecule irradiation in ultra-high-vacuum (UHV), resulting in low-defect non-destructive adsorption, and high H and D coverage on NPG. X-ray photoelectron spectroscopy (XPS) reveals the high H (and D) up-load through the sp^3-distorted component in the C 1s core level, pointing out H-C (and D-C) covalent bonding [4-6]. Raman spectroscopy presents remarkably low-defect and clean H- and D-functionalized NPG. The synthesized H- and D- functionalized NPGs are very stable at unprecedented high temperatures, up to 800 K, with complete desorption only above 920 K. Moreover, ultraviolet photoelectron spectroscopy (UPS) shows an energy band gap opening in the valence band, indicating the H stable isotopes functionalization of NPG. Consequently, this low-defect and highly-loaded H- and D-functionalized NPG with high chemical and temperature stabilities paves not only the way towards fabricating semiconducting *graphane* on large-scale, but it may also represent a guidance for tritium (T, the radioactive isotope of H) functionalization of graphene for futuristic advanced detectors for the β- spectrum analysis [7].

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FIGURES

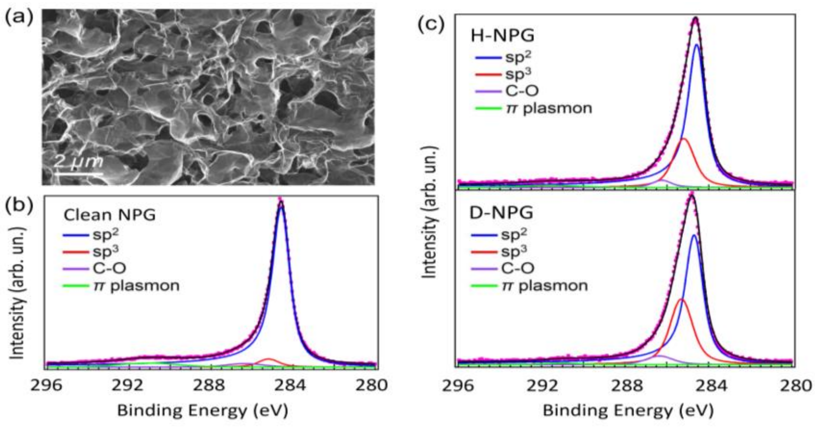

Figure 1: (a) SEM image of the NPG sample; (b) C 1s XPS spectrum of clean NPG; (c) C 1s XPS spectra of NPG exposed to saturation coverage of H (top spectrum) and D (bottom spectrum) using low-energy ion irradiation source.