Electronic Supplementary Information (ESI)

Freestanding silicon films formed on ionic liquid surface

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Experimental section

Preparation of silicon films: In a typical synthesis, ionic liquid of [BMIM][BF_4] (purity>99.5%, Shanghai Cheng Jie Chemical Co. LTD) was pumped continuously for hours to reduce its moisture. Then 2 ml of the liquid was immediately transferred into a cylindrical glass Petri dish (4 cm diameter × 0.5 cm height) mounted on the rotating specimen holder in Cat-CVD chamber. After that, the deposition chamber was evacuated to a base pressure below 8×10^{-4} Pa and the ionic liquid was further dried. The nominal temperature of the liquid substrate was 100 °C that was monitored by a thermocouple attached on the back of the specimen holder. Direct current was used to heat a Ta wire or W wire (Alfa Aesar, Purity>99.95%, 0.5 mm in diameter and about 15 cm in length) catalyst, and its temperature was measured at the middle part by a two-color infrared pyrometer (Raytek, MR1SCCF) with an accuracy of ±20 °C. Ta catalyst with a temperature of 1600 °C was usually used except the synthesis of the samples with 2 and 5 minutes in which W catalyst of 1700 °C was used, and no evident difference would be resulted for the deposition process and the obtained films. A gas mixture of SiH_4 and H_2 (SiH_4=5%) at a flow rate of 20 sccm was introduced to start the film deposition, while the deposition pressure was kept constant at 50 Pa that was monitored by a resistance vacuum gauge. After deposition, the samples were cooled down to room temperature in vacuum. It is important to note that the ionic liquid ([BMIM][BF_4]) demonstrated sufficiently low vapor pressure allowing Cat-CVD to be performed and did not show any structural change during the process, as indicated by its invariable ultraviolet absorption and the rational structural

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change of the metal catalyst identified by XRD characterization (results not shown).

Characterization of silicon films: The as-prepared silicon films were usually transferred though various plates and meshes, and then immersed in ethanol to wash out the adherent ionic liquid for further characterizations. SEM (Quanta 200 F) attached with an EDX was used to identify the structure and components of the films. Raman spectra were recorded on a home-assembled UV Raman spectrograph using a Jobin-Yvon T64000 triple-stage spectrograph. The laser line at 325 nm of a He-Cd laser was used as the excitation source. Parts of the films were loaded onto copper micro-grids and investigated by TEM (Tecnai G2 Spirit) and HRTEM (Tecnai G2 F30 S-Twin) attached with an EDX. Tapping mode amplitude modulated AFM measurements were performed using a Bruker Metrology Nanoscope III-D AFM.

Figures

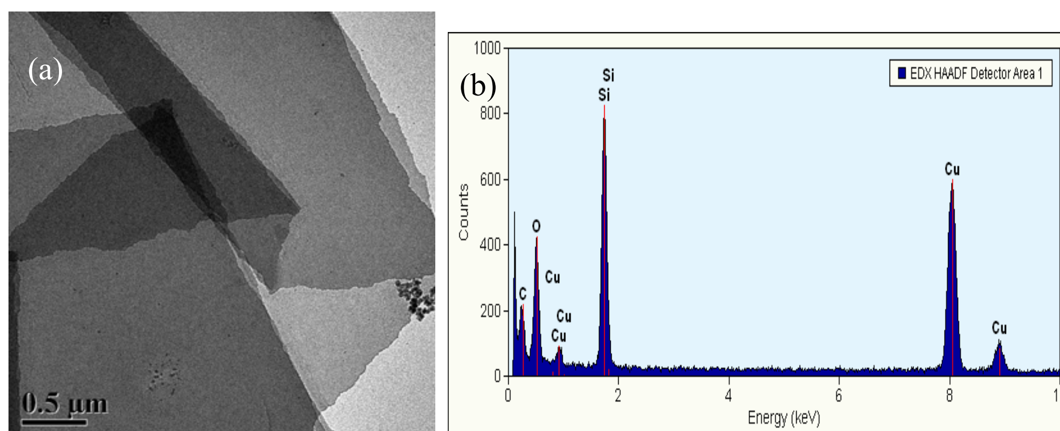

Fig. S1 Low magnification TEM image (a) and EDX pattern (b) of the silicon film deposited on ionic liquid substrate for 30 s. The C, O, Cu peaks are attributed to the Cu micro-grid and the native surface oxide layer on silicon film. There are no detectable ionic liquid components such as F.

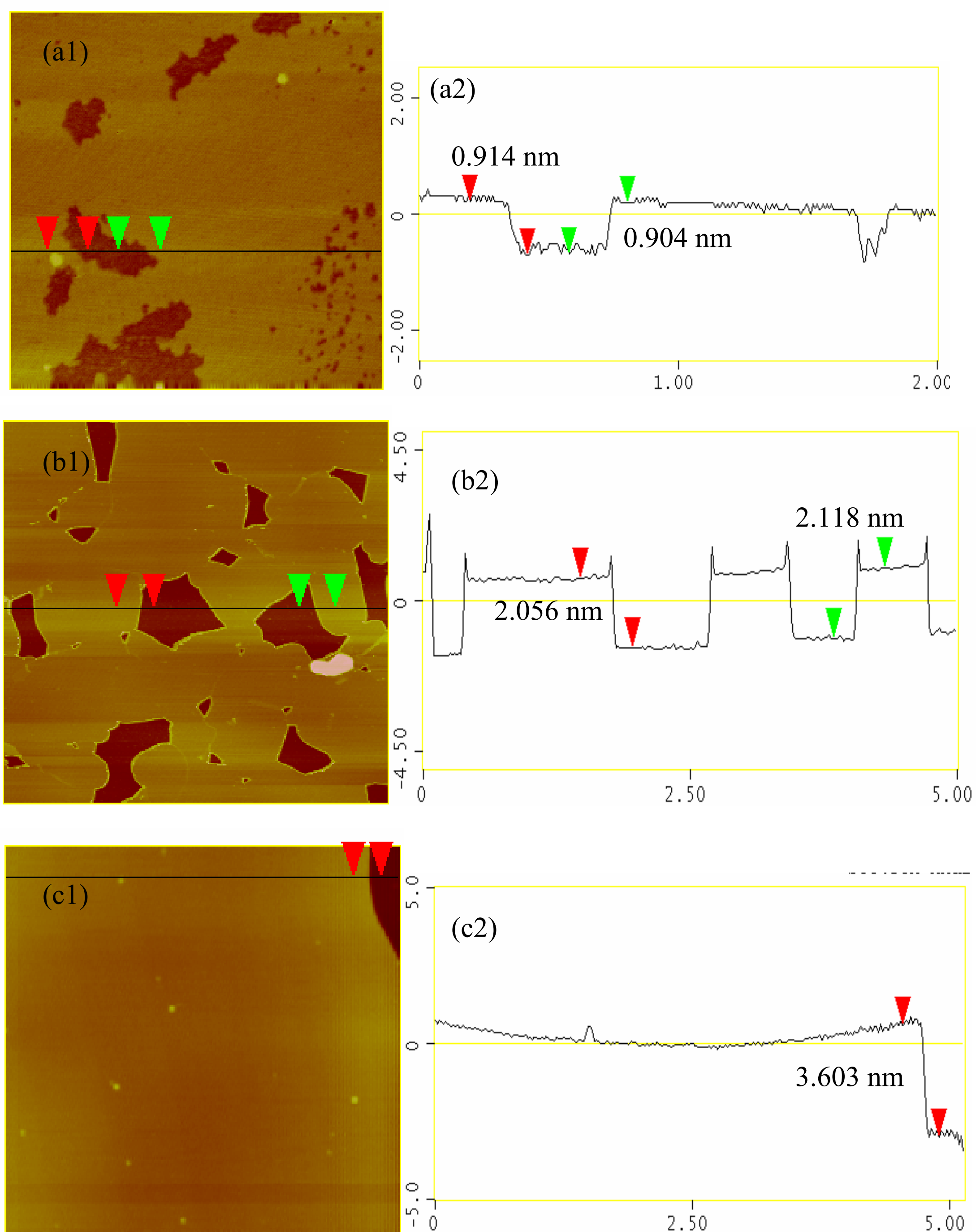

Fig. S2 AFM images and size analysis of the ultrathin films on mica surfaces. The cross-section profiles were obtained along the lines marked in the height images on the left.