Mica Nanosheet Patterned Etching Using Focused Electron Beam

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Among layered materials, mica is a widely-known phyllosilicate mineral with a wide bandgap and has unique optoelectronic properties that provide remarkable impact on flexible electronics. However, the applicability and wide deployment of mica nanosheets in scalable devices has been presently limited by a lack of suitable fine processing techniques, particularly growth and etching. Here we present a focused electron beam (FEB)-induced etching of mica nanosheets (Fig. 1(a)), conducted in a scanning Auger electron spectroscopy (AES) setup (SAM670, ULVACΦ).

The sample was single-crystal oxide of artificially-synthesized phlogopite ($KMg_3AlSi_3O_{10}F_2$), one of mica family, which was exfoliated and the mica nanosheets with ~10 nm thick were affixed on a Si substrate. Figures 1(b) and (c) show the SEM and AFM images etched by the FEB; where few layers (3-5 layers) mica nanosheets were selectively removed by 10 keV and 10 nA beam voltage and current respectively. The etched areas were analyzed by AES spectra. Accordingly, it was deduced that the FEB irradiation dissociates the mica compounds on the surface. The effects of beam current, energy, and scan time were investigated as controlling parameters. The technique enables nanoscale, iterative patterning of mica nanosheets, which can widen the application of mica-based 2D heterostructures and devices.

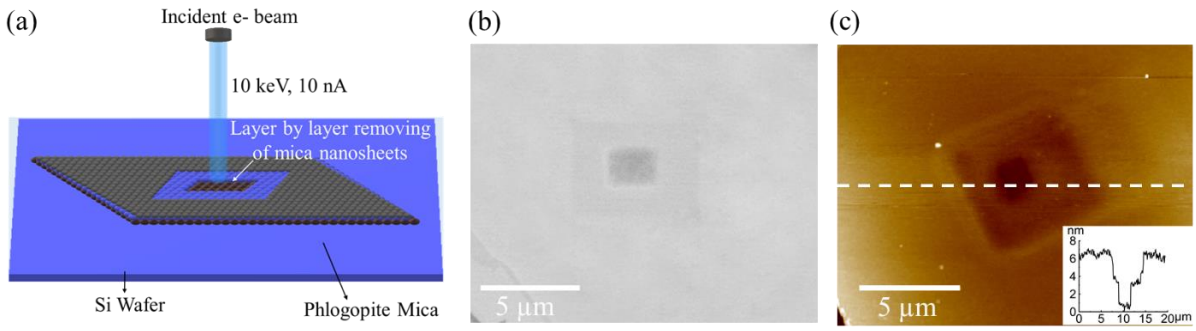

Figure 1: (a) Schematic illustrations of removing mica nanosheets with the focused electron beam, (b) SEM image and (c) AFM image of the selectively removed mica nanosheet area.