Electric, Sensing, and Mechanic Properties of thick cBN and Surface-Modified Ceramic Nanosheets

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Projects: ***To understand how plasma beam techniques used to synthesize thick cBN and few-atom-layer ceramic nanosheets. To understand how chemical modification to control forbidden band gap in order to manipulate insulated, semiconducting properties for the ceramic nanosheets for electric, sensing, mecahnical applications.***

1. Synthesis

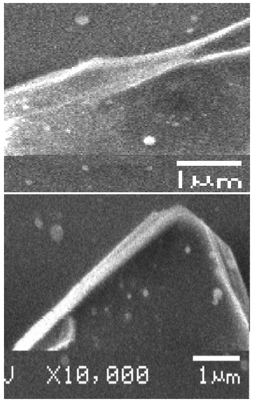

Fig. 1-1. SEM images of the thick cBN films prepared on Si substrate and Mo substrate

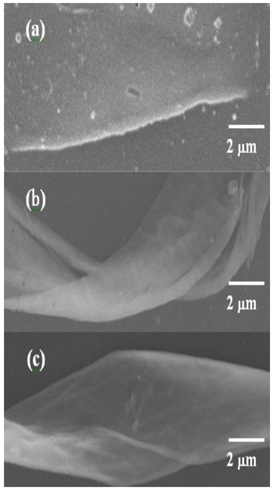

Fig. 1-2. SEM images of few-layer BNNS (thickness: 4 nm) prepared at (a) 700 C, (b) 800^{o}C, (c) 900 ^{o}C

The nanosheet was bended, caused by the residual stresses generated during the growth process. At 900 ^{o}C, high-quality transparent few-layer BNNS with the width up to more than 6 um. The experimental data show that increase of substrate temperature using this approach produces thinner nanosheets

2 Electric and electronic applications

Demonstration of the transition of BNNS from insulator to semiconductor induced by the hydrogen modification. The bandgap of the transparent BNNS is tunable and the width of the gap is dependent of the hydrogen treatment time

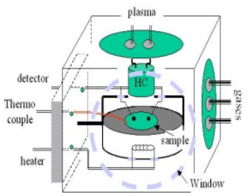

Fig.2-1 Setup

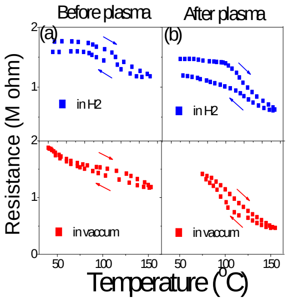

Fig.2-2 Variation of resistance of hBN nanosheets following operating temperature changes

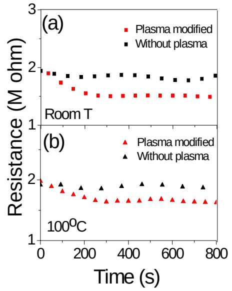

Fig.2-3. Variation of resistance of BN nanosheet following duration time of chemical modification

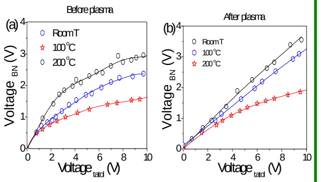

Fig.2-4 Variation of resistance of hBN nanosheets following load voltage

3 Facilities, (available in the Laboratory)

1, DC discharge plasma deposition, spin coating, and sol-gel;
2, RF discharge plasma etching and sputtering deposition system; 3, Plasma cleaner; 4, CVD system;
5,Three high power laser (CO2 laser, super-short-pulse Lamda excime lasers, and super-short-pulse Nd:YAG laser plasma deposition systems;
6, UV and visible spectrometer and visible Monochromator;
7, Raman scattering spectrometer (a Jobin-Yvon T64000 Triple-mate system);
8, Two IBM and three Dell computers;
9, Two microscopes and 2 CCD cameras;
10, Hydrophilic status and cellular adhesion detectors;
11, Photoacoustic accessory for the FTIR that enables to perform non-destructive IR spectroscopy;
12, Highly precise manipulator ;
13, Various electronic equipment including HP 4192A impedance analyzer, remote detector, metal and electronic workshop, etc. for design and characterization of graphene-based FET;
14, Current Voltage (I ~V) Measurements set-up including a Keithley 6517 electrometer capable of measuring currents as low as 10 pA.

4 Collaborations

Partner Organizations:
Institute for Functional Nanomaterials: In-kind Support; Facilities; Collaborative Research; Personnel Exchanges (NSF-Funded, PI: B.R. Weiner)
Other collaborators:
Other collaborators: University of Massachusetts, Center for Nanoscale Materials / Argonne National Laboratory,
Looking for new collaborators: 1, STEM, 2, devices