Morphological and Electrical Studies of Plasma-treated Transition Metal Dichalcogenide Nanosheets

Atsushi Ando1, Jun Miyawaki1, Masayo Horikawa1, Naoya Okada1, Toshitaka Kubo1, Tetsuo Shimizu1, Takahiro Morii1, Kazuhiro Endo2, Kazuhiko Endo1 and Toshifumi Irisawa1

1National Institute of Advanced Industrial Science and Technology (AIST), Tsukuba, Ibaraki, Japan
2Kanazawa Institute of Technology, Hakusan, Ishikawa, Japan

atsushi-ando@aist.go.jp

Transition metal dichalcogenide (TMDC) layered semiconductors such as molybdenum disulfide (MoS2) are gaining attention as next generation nanoelectronic materials [1]. For the realization of practical electronic devices of TMDC, it is important to establish each device fabrication process such as thinning (layer etching), device isolation (isolation of channel region), selective area doping and so on, and utilization of plasma processes are expected. In this work, we investigated the effect of plasma treatments on morphology and electrical properties of TMDC nanosheets.

Plasma treatments were performed with a resist strip system (O2 plasma and N2 plasma) or an “inward plasma” [2] system (CF4 plasma and N2 plasma). The morphology of the nanosheets surfaces after plasma treatments was evaluated by AFM. The crystallinity of the nanosheets after plasma treatments was checked by Raman measurements. Electrical properties of the nanosheets after plasma treatments were studied by characteristics of the FETs whose channels were mechanically exfoliated TMDC nanosheets on a 285 nm thick SiO2 substrate with highly doped silicon [3].

Figure 1 is an example our investigations and shows morphological changes during O2 plasma treatment to a tungsten diselenide (WSe2) nanosheet. By O2 plasma treatment, oxidation of WSe2 and subsequent sublimation of the oxide occur. So, the etching of WSe2 proceeds in a nearly layer-by-layer manner on WSe2 surface. Dangling bonds generated by O2 plasma treatment act p-type dopant behaviour in the characteristics of the WSe2 FET.

The detailed results will be discussed at the presentation.

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References


Figure

Figure 1: AFM images of WSe2 surface after O2 plasma treatment: (a) after 0.4 min irradiation and (b) after additionally 0.1 min irradiation (Total 0.5 min).