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

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Transition metal dichalcogenide (TMDC) layered semiconductors such as molybdenum disulfide (MoS_2) 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 (O_2 plasma and N_2 plasma) or an "inward plasma" [2] system (CF_4 plasma and N_2 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 SiO_2 substrate with highly doped silicon [3].

Figure 1 is an example our investigations and shows morphological changes during O_2 plasma treatment to a tungsten diselenide (WSe_2) nanosheet. By O_2 plasma treatment, oxidation of WSe_2 and subsequent sublimation of the oxide occur. So, the etching of WSe_2 proceeds in a nearly layer-by-layer manner on WSe_2 surface. Dangling bonds generated by O_2 plasma treatment act p-type dopant behaviour in the characteristics of the WSe_2 FET.

The detailed results will be discussed at the presentation.

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References

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Figure

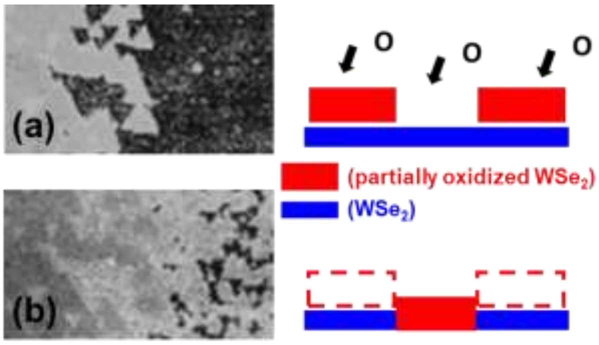

Figure 1: AFM images of WSe_2 surface after O_2 plasma treatment: (a) after 0.4 min irradiation and (b) after additionally 0.1 min irradiation (Total 0.5 min).