Effects of lattice vacancies introduced by ion-beam irradiation in monolayer MoS_2

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In view of verifying the influence by lattice vacancies on the structure and electronic properties, the monolayer MoS_2 sample is irradiated with low energy Ar^+ ion beam in order to introduce vacancies under a well-controlled condition, and evaluated by Raman spectroscopy and photoluminescence (PL).

After Ar^+ ion irradiation, both of the line widths of E_{2g} and A_{1g} peaks for Raman spectroscopy increase and become broad as increasing of irradiation dose. The observed increase of the line width is attributed mainly to the increase of the satellite peaks' contribution caused by the introduction of lattice vacancies [1]. Interestingly, the effect of the irradiation is more significant for E_{2g} in spite of less influence of charge transfer by molecular adsorption, where A_{1g} peak is much more sensitive due to its large electron-phonon coupling [2][3]. As for photoluminescence (PL), the intensity of the peak at 1.84 to 1.88 eV decreases significantly with the emerging of a tail at the lower energy side as the increase of Ar^+ irradiation dose. Interestingly, the peak around 1.35 eV assigned to the emission related to impurity levels also rapidly decreases upon ion beam irradiation.

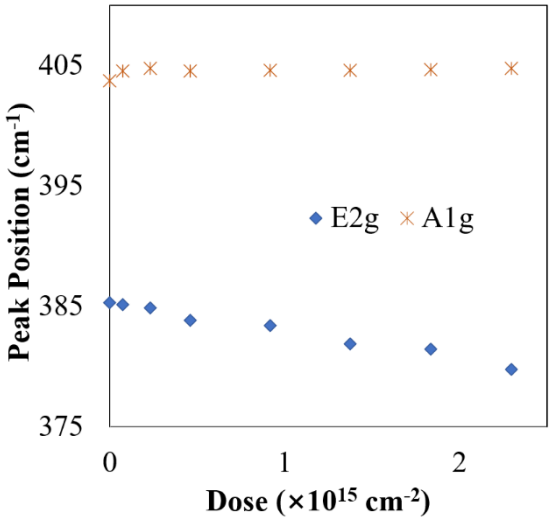

Fig.1 Dosage dependence of Raman peak position for E_{2g} and A_{1g} of monolayer MoS_2 irradiated with Ar^+ ion beam.

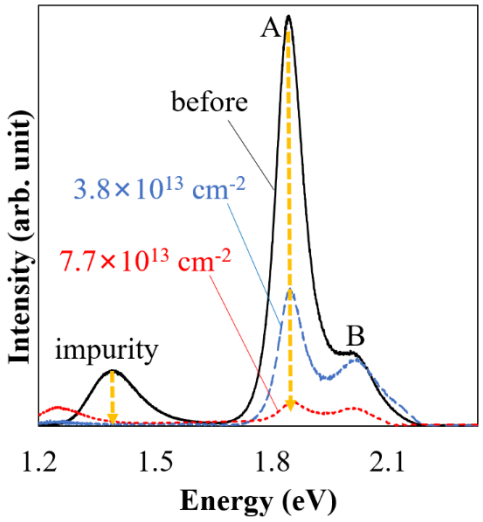

Fig.2 PL spectra for monolayer MoS_2 irradiated with Ar^+ ion beam at dosage of 0, 3.8×10^{13} cm^{-2}, 7.7×10^{13} cm^{-2}.

[1] Soungmin Bae et al., Phys. Rev. App., **7**, 024001(2017).
[2] B. Chakraborty et al., Phys. Rev. B, **85**, 161403(2012).
[3] N. Kodama et al. FNTG(2018).