surface effect of the nanostructures. Because of the larger surface-to-volume ratio of the nanowires, a higher fraction of gold atoms resides on the surface and more damage processes can occur on the surface of the nanowires. This can result in the enhanced surface damages and high sputtering yields in the case of thin NWs[1].

Meanwhile, the sputtered nanoparticles(NPs) from the gold NWs were also observed, as shown in Fig. 2(a∼d), these particles around the gold NWs are collected by the carbon membrane of the TEM grid. And most of them distributed around the parent NWs are in the range of 200 nm. As the nanowire's diameter increases, the amount of the sputtered particles increases due to the increased impact of the cross section. In these work, we considered that the formation of these NPs are the molten gold ejected from a displacement cascade in gold NWs[2].

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4 - 29 Damage Effects of CVD Single-layer MoS_2 Irradiated by Heavy Ions

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This work is mainly to study the effect of heavy ion irradiation on the damage of single layer MoS_2. The number of layers of MoS_2 prepared by CVD (chemical vapor deposition) method was determined by optical microscopy and Raman spectroscopy. The monolayer MoS_2 prepared by CVD under high energy ^{209}Bi ion irradiation was analyzed by Raman analysis and AFM observation. And the results are compared and analyzed before and after the beam irradiation of single layer MoS_2 prepared by mechanical stripping method.

Fig. 1 (a) shows the Raman spectra of the single-layer MoS_2 samples corresponding to different fluence ($5\times10^{10}\sim 1\times10^{12}$ ions/cm^2) before and after irradiation with ^{209}Bi ions. It is obvious that the MoS_2 characteristic peak and the peak intensity of E^1_{2g} and A_{lg} peak are obviously weakened with the increase of irradiation fluence. As shown in Fig. 1 (b), the peak intensity of A_{1g} peak decreased from 3 439 a.u down to 989 a.u after irradiation.

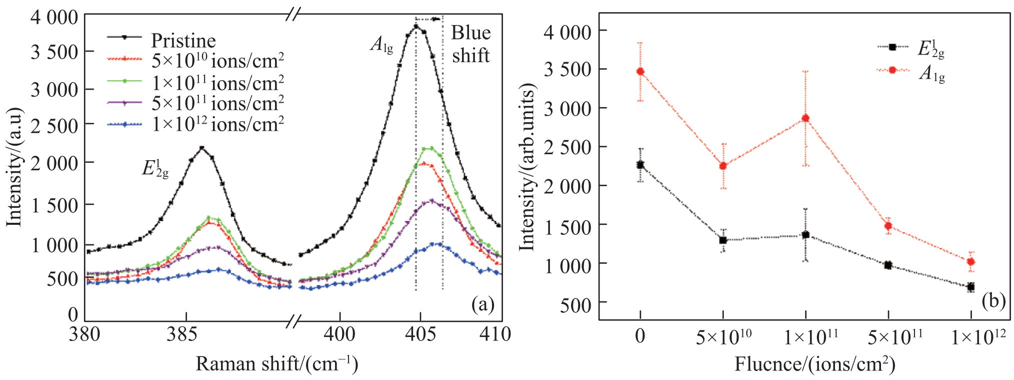

Fig. 1 (a)Raman Spectra of MoS_2 Irradiated by ^{209}Bi Ions (b)The trend of the intensity of the peak of E^1_{2g} and A_{1g}.

According to the calculation of the first principle, the S atom vacancy caused by the Bi ions in the latent tracks will adsorb the oxygen molecules with the binding energy of up to 2.395 eV in the air. Due to the high binding energy, and the free electrons in MoS_2 are extracted to form bound excitons. The surface electron density is reduced and the p-type doping is carried out[1], and then the decrease in the number of excitation directly leads to the weakening of the Raman signal, which is reflected in the weakening of the Raman characteristic peak.

In the process of CVD preparation, the surface of the SiO_2 substrate will be deformed due to the tension, the surface of the MoS_2 grown by the redox process will be uneven, resulting in slight hillocks wrinkles. Fig. 2(b) shows the flatness of the general but the continuity of the sample. At the slightly protruding or folds, the interlayer has a weak interaction force - van der Waals force, and the combination of strong interaction force - Coulomb force, both influences the inner surface electron density of the layer between the single and double layer. And the A_{1g} pattern is the representative of the vibration mode in the layer. Its phonon frequency is affected by the electron density, then the performance in the Raman spectrum is blue shift. The peak spacing is shown same to the double peak difference of 1∼2 layers of MoS_2 prepared by mechanical stripping method.

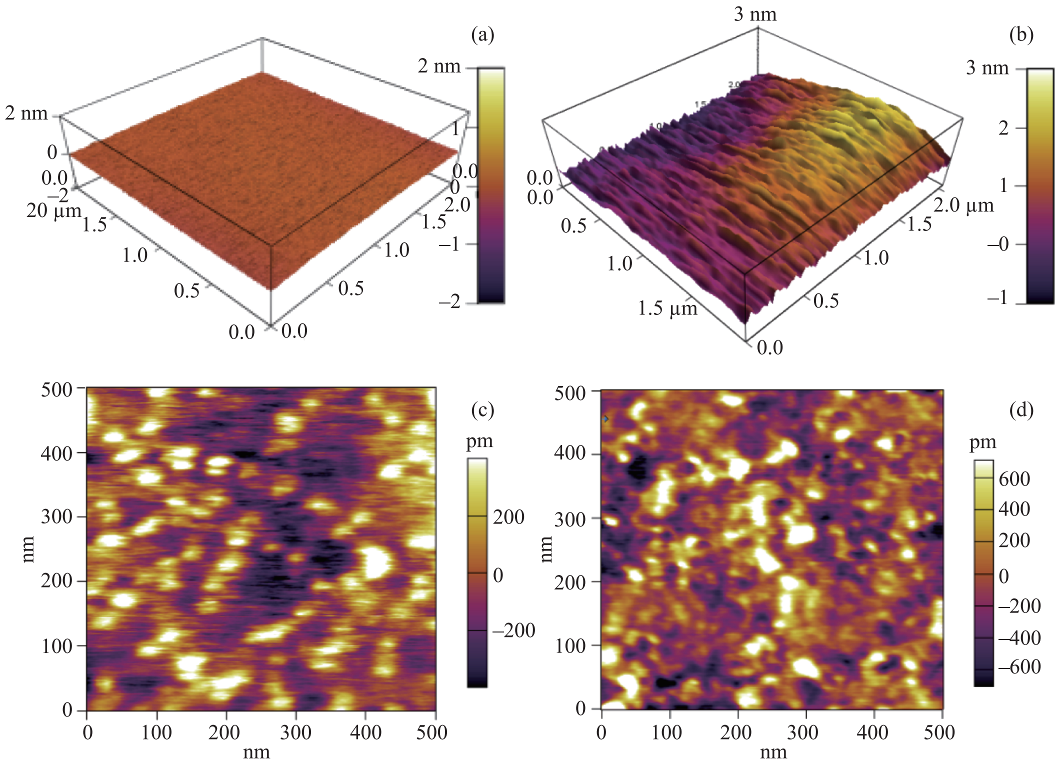

Fig. 2 (a) Mechanical stripping method Single layer MoS_2 sample AFM observation under 2 μm base plane, (b) CVD method single layer MoS_2 sample AFM observation under 2 μm base plane, (c) AFM of mechanical stripping method single layer MoS_2 irradiated at 5×10^{10} ions/cm^2, (d) AFM of CVD single layer MoS_2 irradiated at 5×10^{10} ions/cm^2.

From the comparison of Fig. 2(c)[2]and (d), it was found that after irradiation with the same fluence (5×10^{10} ions/cm^2), the surface morphology of AFM observed at the same scale (500 nm). The CVD MoS_2 sample has a much smaller number of hillocks than the mechanical stripping method, while the pits are much more. This is due to the difference in the preparation of their own means, in the transfer of ME method, we need to use tape to press the substrate (CVD is natural growth), so that the surface stress itself makes the degree different. At the same time MoS_2 adhesion between the substrate will be weaker than the mechanical stripping method sample, so after the ion transmission of the MoS_2 layer and the substrate by the collision of atoms, the effect obviously weakened.

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