tical band-gap[4]. Considering both the effects of crystallite size and short-range order, the reduction of optical band-gap should be considered as a combined result of the structural damages of crystalline and amorphous phases induced by the irradiation. And for samples irradiated with 196 MeV Kr-ions, the ion irradiation just results in a slight change of the crystalline fraction and crystallite size. Such a small structural change of crystalline phase in the films does not influence the optical band-gap significantly (Fig. 2). Therefore, we consider that the decrease of optical band-gap for samples irradiated with 196 MeV Kr-ions is mainly attributed to the reduction in the short-range order of amorphous network.

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3 - 2 Raman Scattering Analysis of a-Si∶H Films Irradiated with 500 keV He-ions

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As one of the most important semiconductor materials, hydrogenated amorphous silicon (a-Si∶H) film has been widely applied in solar cells and thin film transistors due to its remarkable photoelectric property and the low cost. Ion irradiation is an effective tool to modify the structural, optic, electronic and mechanical properties of materials. Studies about the irradiation effects of a-Si∶H film induced by energetic heavy-ions possess not only the important significance but also the potential application prospects.

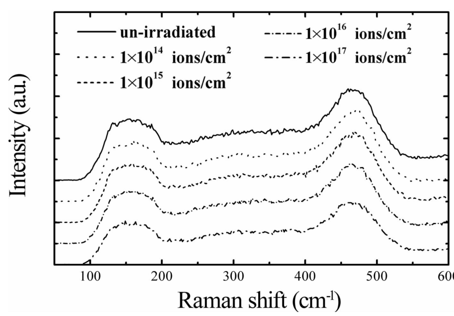

Fig. 1 The Raman spectra of a-Si∶H films irradiated with different fluences.

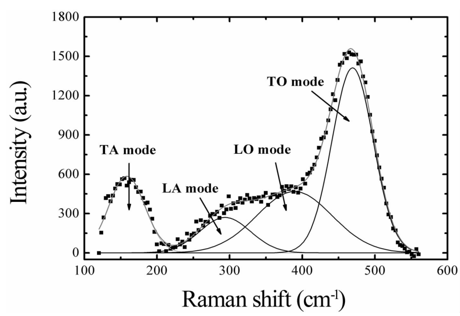

Fig. 2 The deconvoluted Raman spectrum for the un-irradiated a-Si∶H film.

In present work, a-Si∶H films with thickness of 300 nm were deposited on glass substrates by using radio-frequency magnetron sputtering. And then, the samples were irradiated at room temperature with 500 keV He-ions. The irradiation fluences are 1.0×10^{14}, 1.0×10^{15}, 1.0×10^{16} and 1.0×10^{17} ions/cm^2, respectively. Raman spectroscopy and UV-Vis transmission spectra were used to study the structural changes induced by the irradiation. Fig. 1 shows the Raman spectra of a-Si∶H films irradiated with different fluences. As is well known, the Raman spectrum of a-Si∶H film is consisted by four bands, which includes the transverse acoustic (TA) mode at 150 cm^{-1}, the longitudinal acoustic (LA) mode at 310 cm^{-1}, the longitudinal optic (LO) mode at 380 cm^{-1} and the transverse optic (TO) mode at 480 cm^{-1}[1]. The deconvoluted Raman spectrum of un-irradiated a-Si∶H films is shown in Fig. 2. The ratios of integrated intensities of TA and LA peaks over that of TO peak (TA/TO, LA/TO) and the FWHM of TO peak varying with the irradiation fluence are presented in Fig. 3. With the fluence increases from 0 to 1.0×10^{17}

ions/cm^2, the values of TA/TO and LA/TO increase from 0.27 to 0.37 and from 0.15 to 0.23, respectively. The FWHM of TO peak increases from 66.9 to 69.8 cm^{-1} after irradiation. These results indicate that the irradiation results in the decrease of the short-range structural order of the amorphous network in the samples[2]. The optical band-gap of a-Si:H films decreases from 1.99 to 1.72 eV as the ion fluence increases from 0 to 1.0×10^{17} ions/cm^2, as shown in Fig. 4. The reduction of optical band-gap is related with the decrease of short-range structural order, which widens the band-tails of valence and conduction bands, and then results in the decrease of optical band-gap[3].

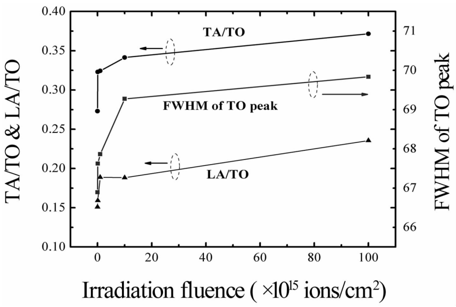

Fig. 3 The values of 3 samples as a function of ion fluence.

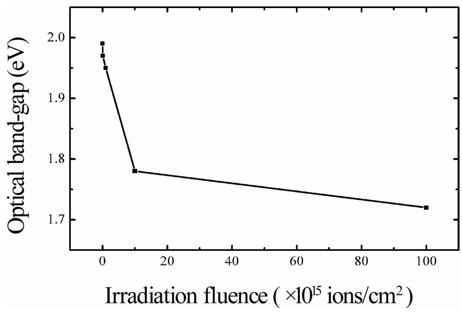

Fig. 4 The optical band-gap varying with the ion fluence.

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3 - 3 Local Crystallization induced by Swift Heavy Ion Irradiation in FeSiNbZrB Metallic Glass

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Metallic glass (also known as amorphous alloy) is a kind of new alloy materials synthesized by using modern rapid solidification metallurgical technology, owning excellent mechanical, physical and chemical properties that general metal and glass have. Its unique glassy structure leads to its high performance (such as high strength, corrosion resistance, great ductility, and having a wide supercooled liquid region, etc., just like the high-quality magnetic functional materials), generating enormous potential for development and application[1-3]. Along with the in-depth research and development of metallic glass materials, two fundamental but not yet answered scientific questions inevitably lay in front of us: what are the mechanisms of the relaxation behavior as well as the plastic deformation of the metallic glasses? The exogenous energies (force, heat, etc.) can lead to the transition between the glass localized in the shear deformation and shear zones and the liquid[3]. As is well known, conventional energetic ions lose energy in materials by inelastic and elastic collisions, and these energy losses are termed as electronic (S_e) and nuclear (S_n) stopping powers, respectively. So, ion irradiation process is a kind of special exogenous energy deposition process in materials. In order to understand the relaxation behavior and plastic deformation mechanisms of the metallic glass, in our experiment, swift heavy ion (SHI) irradiation as a kind of special non-equilibrium and exogenous energy deposition process will be applied to the study on the mechanisms of relaxation and plastic deformation of the metallic glass.

FeSiNbZrB ($Fe_{77.5}Si_{9.5}Nb_{3.0}Zr_{1.0}B_9$, at%) amorphous ribbons (2.0 mm×0.02 mm in size of cross section) were prepared by melt spinning method. And the SHI irradiation experiment was performed on the material research terminal of the 320 kV ECR platform at the Institute of Modern Physics (IMP), Lanzhou. In experiment, amorphous FeSiNbZrB alloy ribbons were irradiated at room temperature (RT)