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The study of damage produced by H-ion and He-ion implantation in Lithium tantalate crystal

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Synopsis $LiTaO_3$ single crystals were implanted by 100keV H-ion or He-ion. The results indicate that H-ion implantation creates a lower damage level than the He-ion implantation does, but the yield of oxygen vacancy produced by H-ion implantation is far higher than by He-ion implantation.

Lithium tantalate ($LiTaO_3$) is an important multi-functional material because of its excellent piezoelectric, ferroelectric, acousto-optic and electro-optical effects[1]. Recently, this kind of crystal exhibits a promising prospect for optical waveguide fabrication by light ion implantation[2]. In this work, we will focus on the damage induced by H/He ions implantation in the $LiTaO_3$ single crystal.

Z-cut $LiTaO_3$ single crystals were implanted by 100keV H-ion or He-ion at the fluences of 1.0×10^{16} and 1.0×10^{17} ions/cm^2, respectively. Fig.1 shows the transmission spectra of the samples at different fluences. Both H-ion and He-ion implantation induce the decrease of transmittance in the visible region and the near-UV region. This indicates that great many point defects of oxygen vacancies are produced in the crystal, which results in a strong optical absorption near the 460 nm[3]. It also can be found that the optical absorption induced by H-ion implantation is more intense than that induced by He-ion implantation. This implies that H-ion implantation created more oxygen vacancies in the crystal.

Fig.2 shows the Rutherford backscattering-channeling spectra of samples at different fluences. For the sample implanted with 100keV H-ion at the fluence of 1.0×10^{17} ions/cm^2, there is a obvious damage peak created in the crystal, about 0.23 dpa of damage level according to the simulation result from SRIM2008[4]. However, for the sample implanted with 100keV He-ion, at the same fluence, the damage peak almost approaches the amorphization, and the corresponding damage level is about 2.2 dpa. It is obvious that He-ion implantation created greater damage level, comparing with the H-ion implantation.

Therefore, in the case of 100keV H-ion or He-ion implanted in $LiTaO_3$ single crystals, H-ion implantation creates a lower damage level than the He-ion implantation does, but the yield of oxygen vacancy produced by H-ion implantation is far higher than that produced by He-ion implantation.

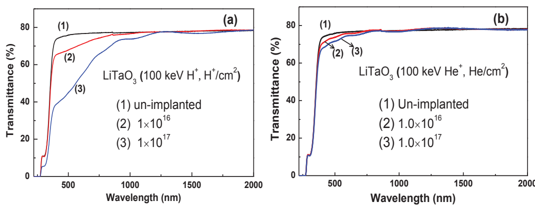

Figure 1. The transmission spectra of the samples with H-ion (a) or He-ion implantation (b) at different fluences.

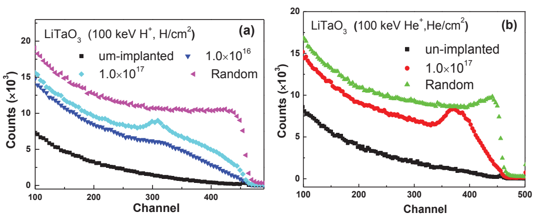

Figure 2. The Rutherford backscattering-channeling spectra of samples with H-ion (a) or He-ion implantation (b) at different fluences.

References

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