Ion Channeling Implantation Induced MgF_2 Crystal Damage through the "Eye" of Photoluminescence Spectroscopy

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Abstract. Magnesium fluoride (MgF_2) single crystal has been widely used as a material for application in optics due to its excellent properties like birefringence, wide range of transparency and low refractive index. As such, MgF_2 has been proposed for planar waveguide structures. Ion implantation method was frequently used for planar waveguide production due to its ability to modulate optical properties by introduction of impurities and defects in crystal lattice. In all optics fabrication processes, there are demands for a precise control of optical characteristics modulation and hence the need for precise distribution of implanted impurities and induced damage. In this study, 4 MeV C^{3+} ions with the fluence of 5×10^{15} ions/cm^2 were implanted in (001) axial direction of MgF_2 single crystal. In order to determine the damage depth distribution in the crystal sample, photoluminescence (PL) spectroscopy was proposed as a method of evaluation. PL spectroscopy was used as a convenient method for damage investigation of transparent and semi-transparent samples. The cross-section of the implanted zone was mapped with the step of 0.34 μm and the variations in the spectra were investigated. It was shown that intensity evolution of two prominent wide bands with the intensity maximums at about 590 nm and 733 nm can be used for damage depth distribution estimation. Comparing the relative changes of derivatives of the band's intensities, data related to the damage depth distribution were obtained. Obtained distribution was compared with the SRIM calculation of displacement damage. Considering the difference in implantation direction, good agreement with SRIM results was obtained. As a consequence of ion channeling, it was shown that damage distribution is extended deeper (for about 20%).