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Design and fabrication of waveguides and optical gratings in crystals and glasses via swift heavy ion irradiation

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Active and passive optical waveguides are fundamental elements in modern telecommunications systems. A great number of optical crystals and glasses were identified and are used as good optoelectronic materials. However, fabrication of waveguides in some of those materials remains still a challenging task due to their susceptibility to mechanical or chemical damages during processing. Researches were initiated on ion beam fabrication of optical waveguides in tellurite glasses. Channel waveguides were written in Er: TeO2–WO3 glass through a special silicon mask using 1.5 MeV N+ irradiation. This method was improved by increasing N+ energy to 3.5 MeV to achieve confinement at the 1550 nm wavelength, too. An alternative method, direct writing of the channel waveguides in the tellurite glass using focussed beams of 6–11 MeV C3+ and C5+ and 5 and 10 MeV N3+, has also been developed. Channel waveguides were fabricated in undoped eulytine-(Bi4Ge3O12) and sillenite type (Bi12GeO20) bismuth germanate crystals using both a special silicon mask and a thick SU8 photoresist mask and 3.5 MeV N+ irradiation.
By using even higher energy irradiation, 25 MeV C5+ at low doses, planar optical waveguides were fabricated in sillenite-type BGO crystal.
Focussed ion beam (11 MeV C3+, 10 MeV N3+) irradiation was also used to fabricate transmission optical gratings in Pyrex and Er: TeO2–WO3 glasses, sillenite type BGO and LiNbO3 crystals. The waveguides were studied by phase contrast and interference microscopy and micro Raman spectroscopy. Guiding properties were checked by using m-line spectroscopy and the end fire method.

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