The electro-optic signal improvement by ZnMgTe/ZnTe waveguide structures

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(Introduction) Electro-optic (EO) materials have been widely utilized to develop practical devices. ZnTe is one of the attractive crystals with a high EO coefficient (4.5pm/V). The phase shift occurred in EO materials is a function of the applied electrical field, hence thin film EO devices can have better sensitivity than bulk devices at a given voltage. In this study, we have fabricated the ZnMgTe/ZnTe waveguide by molecular beam epitaxy (MBE) and compared the EO characteristic with that of bulk ZnTe.

(Experiment) 40μm thick undoped (001) ZnTe substrates were used to form the bulk device, and a $Zn_{0.8}Mg_{0.2}Te$(0.3μm)/ZnTe(7.3μm)/$Zn_{0.8}Mg_{0.2}Te$(0.3μm) waveguide structure was grown on the (001) oriented conductive P-doped ZnTe substrate by MBE [1]. Gold stripes were then vacuum evaporated on top of the device to form the cavity (0.25mm wide). The cleaved edge was obtained and no dielectric coating was performed (2mm & 1.5mm long). Continuous wave laser beam was used for the input signal. 1.55μm laser (45° linearly polarized to cladding/core layers interface) was guided to the devices using a lensed fiber. Propagated light was collected by a condenser lens and passed through a 1/4-waveplate, a 1/2-waveplate and a polarizer, then guided into a photo-diode which converts light intensity to electrical output signal. 3.3ms pulse voltage was applied between the top gold electrode and the bottom of the substrate (grounded). The output signal modulation was observed by an oscilloscope.

(Results) An EO crystal can be seen as a voltage-controlled waveplate which can modulate the light polarization state. For a linearly polarized input, the output polarization will be elliptical, rather than a linear polarization state with a certain direction. A polarizer can only pass the polarized light that parallels to it which indicates that we can observe light intensity modulation originate from the phase shift that occurred in an EO crystal. Fig.1 and Fig.2 show the output signal and applied voltage signal of bulk ZnTe device and ZnMgTe/ZnTe waveguide, respectively. The output signal of devices were about 150mV, 450mV at 0V and decreased about 2mV, 120mV when -10V were applied. Main reason that signal intensity diminution of waveguide was larger is probably because the thickness of the core layer (7.3μm) was much thinner than the bulk device (40μm) and the external field was stronger. This result indicated that ZnMgTe/ZnTe waveguide structure could improve the electro-optic signal with higher sensitivity. We can further improve the sensitivity and the optical performance by optimizing the thickness and Mg composition in the waveguide structure.

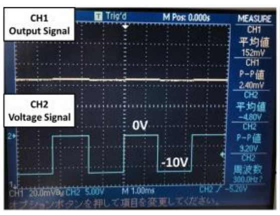

Fig.1 Output signal of the ZnTe bulk device using -10 V pulse function.

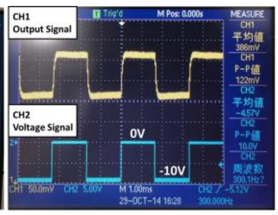

Fig.2 Output signal of the ZnMgTe/ZnTe waveguide using -10 V pulse function.

This work was supported in part by Waseda Univ. Research Initiatives, "Early Bird" grant for young researcher at Waseda Research Inst. for Sci. & Eng., collaboration between Mitsubishi Mat. Corp. & Faculty of Sci. & Eng., the Foundation of Ando Lab., JX Min. & Met. Corp. a Grant of the Strategic Research Foundation. And specially gratitude Dr.Togo of NTT Corp.

[1] W. Sun & etc. phys. stat. sol. (c) 11, 7, 1252 (2014)