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Organic electro-optical modulator with sol-gel SiO_2/carbon nanotube clad layer

Feng Yu[1], Kazuhiro Yamamoto[1], Feng Qiu[1], Shiyoshi Yokoyama[1]

[1] Institute for Materials Chemistry and Engineering, Kyushu University, 6-1, Kasuga 816-8580, Japan

E-mail: yk-y-feng@cm.kyushu-u.ac.jp

1 Introduction

Organic electro-optical (EO) materials have been widely developed for high frequency modulators due to its low cost, high EO coefficient and easy for fabrication[1, 2]. Generally in EO modulator, EO materials are used for core which is sandwiched by top and bottom clad layers. Typically organic EO materials have larger conductivity compared with clad layer materials, so it is important to choose a suitable clad materials which have a compatible or large conductivity, low refractive index, and low optical loss. Here we demonstrate an EO modulator in which a sol-gel SiO_2 doping with carbon nanotube are used for clad layers.

2. Experiment and result

Waveguide structure

The cross section of this modulator was shown in Figure 1 a). EO polymer was used for core layer while sol-gel SiO_2/CNT was used for clad. The thickness of bottom clad layer, core layer and top clad layer are 1.7 μm, 12 μm, 1.5 μm, respectively. The width and the ridge depth are 4.3 μm and 0.250 μm, respectively.

Fabrication and poling

Bottom electrode was thermal deposited on Si wafer. Then sol-gel SiO_2/CNT was spin coated on the electrode. After baking, the waveguide structure was transfer to the sol-gel SiO_2/CNT layer. EO polymer was spin coated to generate a 1.2 μm thickness film. The EO polymer was baked at 120℃ over 24 hours in vacuum to make sure the solvent have been totally moved out. On the EO film, top clad layer was spin coated. Finally the top electrode was sputtered on the top clad.

The modulator was poled by a 50V/μm DC electric field at 130℃ which is near the glass transition temperature of EO polymer. After poling, the sample are cleaved for optical test.

Result

The modulator was measured by a lensed single mode fiber coupling measurement system. Two six-dimensional control were used to tune the coupling condition. The polarization of input light was fixed at 45℃. The output light was collect by a 20X objective lens. The wavelength of light was 1550 nm. The propagation optical loss was measured to 7dB/cm. The output light intensity can be modulate by adding DC or AC voltage. Figure 1 b) shows the relationship between output light intensity and DC voltage. According to Figure 1 b), the Vπ of this modulator is measured as 30 V, which means the figure of merit (Vπ L) is about 15 V· cm. This result can be improved either by increasing the poling voltage which probably gives a larger EO coefficient in device.

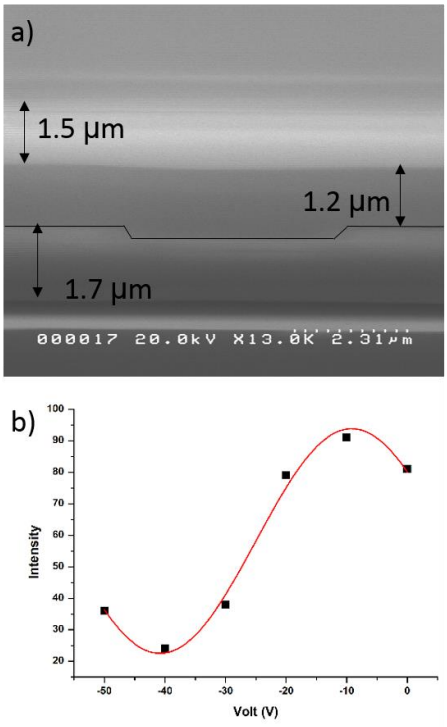

Figure 1 a) The SEM image of cross section
b) The relationship between output intensity and DC voltage

3. Conclusions

An Organic EO modulator using sol-gel/ CNT clad layer have been demonstrated. The figure of merit of this modulator is 15 V· cm.

References

[1] Feng Yu, A.M.Sping, J.Polymer Sci. Part A, **51**(2013) 1278
[2] Y.Enami, Nature Photonics, 1(2007)180