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Facile Fabrication of Polymer Waveguide by Using Photosensitive Polyimides

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Polymers are one of the most promising candidates for the optical materials to fabricate waveguide due to the several advantages over the inorganic materials.[1-3] Conventional processing steps for fabricating polymer optical waveguides include the spin-coating of a polymer thin film from a solution, the photolithographic patterning of a photoresist etch mask to define the waveguide structure, and plasma etching to form a channel waveguide structure in the polymer film. To develop optical polyimides with low loss and high thermal stability and the novel facile fabrication method of passive waveguide by photo-defining refractive indices of the polymer, we synthesized a series of photosensitive fluorinated polyimides based on chalconediamines (4DAC and 3DAC) and other fluorinated diamines (BTBZ, 6FDAM-m, 6FDAM-p and 9FDAM) with aromatic dianhydride (6FDA). The photodimerization of chalcone moieties in polyimides induced a change in the refractive indices of the material mainly due to the destruction of π-conjugation. The refractive indices of transverse electric mode (TE) decreased more largely than those of transverse magnetic mode (TM) with irradiation. As a result, the optical birefringence (Δn) decreased with the irradiation for all polymers. It was remarkable that some of the polyimides irradiated at 50 °C showed zero birefringence (Δn = 0). This was the first reported of zero birefringence in the rigid aromatic polymer systems.

Based on the above advantages such as low optical loss, low birefringence, excellent thermal stability, and most of all, ability to control the refractive index by photoirradiation, we developed a novel fabrication method of passive waveguide.[4-5] In this method, compared to the conventional fabrication methods which are based on the lithographic patterning processes including wet photopatterning and reactive ion etching (RIE) technologies, only by the irradiation on the side cladding layer without wet process, micropattern of core having a higher refractive index than the side cladding area was easily achieved. Channel waveguide was fabricated successfully by using this technique, and exhibited a single mode operation with the propagation loss of 1.08 and 0.77 dB/cm at 1.55 and 1.3 μm wavelengths, respectively.

Optical Properties
Curing temperature.

References

1. R. Moosburger, G. Fischbeck, C. Kostrzewa, B. Schuppepert, K. Petermann, *Proc. Am. Chem. Soc.*, **75**, 373 (1996).
2. J. Kobayashi, T. Matuura, S. Sasaki, T. Maruno, *Appl. Optics*, **37**, 1032 (1998).
3. T. Matsuura, N. Yamada, S. Nishi, Y. Hasuda, *Macromol.*, **26**, 419 (1993).
4. J.-W. Kang, J.-J. Kim, J. Kim, X. Li, and M.-H. Lee, *IEEE Photon. Tech. Lett.*, **14**(9), 1297 (2002).
5. M.-H. Lee, X. Li, J. Kim, J. Kang, S. Paek, and J. J. Kim, *Mol. Cryst. Liq. Cryst.*, **377**, 7 (2002).