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Refractive Index Control of the Polysilane and Evaluation of Possibility to Adopt the EO Polymer as Optical Waveguide Material

Kaoru SUGIMOTO[1,3,*], Shinya SASAKI[2], Tomoyuki AKAHOSHI[2,3] and Mitsuhiro WATANABE[3]

[1]Fujitsu Interconnect Technologies Limited, 1-1, Kamikodanaka 4-chome, Nakahara-ku, Kawasaki-shi, Kanagawa 211-8588, Japan

[2]Fujitsu Laboratories Limited, 10-1 Morinosato-Wakamiya, Atsugi, Kanagawa, 243-0197, Japan

[3]Graduate School of Engineering, Kanto Gakuin University, 1162-2, Ogikubo, Odawara-shi, Kanagawa 250-0042, Japan

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Abstract

A silicone based polymeric material polysilane can be used to form an optical waveguide with the photo-bleaching method. Combined with a single-mode fiber using a long wavelength band, it is also possible to use it as an optical device. However, it is still quite rare to find an optical device using these kind of polymeric materials as a waveguide. When making a waveguide for a single-mode type waveguide device, the control of the refractive index difference of the waveguide material becomes extremely important. To develop the optical device performance, the refractive index is also required to have a variable function. In this study, we evaluated the bake and exposure process conditions to control the refractive index of the polysilane and we investigated the possibility to use the EO (Electro-Optical) material as a host polymer.

Keywords: Optical waveguide, Polysilane resin, Single mode, Refractive index, EO Polymer

1. Introduction

A silicone based polymeric material polysilane can be applied to a 1550 nm long wavelength. It can be applied as an optical switch as well as an attenuator by combining it with a single mode fiber for long-distance communication to an optical device. A lot of studies were conducted on the evaluation of basic waveguide with polysilane, but only few covered the specific device forming all the core and clad [1-6]. The MZ (Mach-Zehnder) type modulator is the most widely used device for optical switch applications. This switch is made of a material called LnNbO3. Studies on the EO effects by using a polymeric material are also limited [7-10].

In this study, we develop and evaluate a polysilane resine base waveguide for polymer devices covering a long-wavelength band (1550nm). First, we investigated the refractive index control to form a single-mode type waveguide. The bake and exposure process conditions for an optimal refractive index at the waveguide formation were evaluated and the propagation loss in the channel waveguide was observed. Considering that the EO pigments have an optical attenuation function due to the electro-optical effect, we evaluated the possibility of using an EO material made of EO pigments and polysilane. In order to create the EO material, we evaluated to viability of the EO material as a host polymer. The electro-optical effect was measured by the EO coefficient as EO materials contains pigments [11].

2. Experimental method

2.1 Waveguide forming

2.1.1 Refractive index observation of the slab-waveguide

In order to form a slab-waveguide, a 4 inch glass wafer (Pyrex glass, thickness: 2 mm) was used as a base waveguide substrate and the polysilane was spin coated targeting a 10 µm thickness. Then, the polysilane was cured by the pre-bake and post-bake processes. Furthermore, the exposure effect was

*Corresponding author: sugimoto.kao@jp.fujitsu.com