Fabrication of Polymer Bragg Grating Waveguide Devices Using MEMS Technology

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Abstract— In this paper, we proposed a novel process to replicate the polymer submicron range Bragg grating wavelength filter by using holographic interference techniques, soft lithography, and micro molding. The grating structure on a polymer is fabricated first using holographic interferometry and micro-molding processes. In this experiment, the master of the periodic structure was created on an i-line submicrometer positive photoresist film by a holographic interference using a He-Cd (325 nm) laser. A subsequent mold using polydimethylsiloxane (PDMS) polymer was cast against this master and used as a stamp to transfer the grating pattern onto a UV cure epoxy. Based on our AFM and SEM results, we found that the grating period and the corresponding depth of the grating pattern can be accurately controlled down to less than 1% error. We also found that a high aspect ratio of almost $0.7:1$ between the depth and the period of the grating structure could be obtained using this process.

The polymeric wavelength filters are produced by a two-step molding process where the master mold is first formed on a negative tone photoresist and subsequently transferred to a PDMS mold; following this step, the PDMS silicon rubber mold was used as a stamp to transfer the pattern of the polymeric wavelength filters onto a UV cure epoxy. Initial results show good pattern transfer in physical shape. The waveguide properties including the mode pattern and the effective index were simulated using the beam propagation method. The effective index of the waveguide is 1.5447 from the simulation. The Bragg wavelength is 1553.9 nm as calculated from the Bragg reflection condition. The transmission of the optical filter was also calculated by using coupled mode theory. The calculated transmission minimum of the optical filter is -19.5 dB. The spectral characteristics of the optical filter were measured using an optical spectrum analyzer. The measured result shown, at the Bragg wavelength, a transmission dip of -18.5 dB was obtained, and the 3-dB-transmission bandwidth was about 8 nm. The result is consistent with the calculation of the coupled mode theory. The measured Bragg wavelength is 1554.02 nm, which is off by 0.12 nm from the theoretical prediction.