Tunable Bragg Gratings in Polymer Thin Films

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Present optic network development places ever-increasing speed requirements on photonic devices which are difficult to meet with conventional electronics. Tunable Bragg gratings incorporated with the electro-optic effect of non-linear optical chromophores would provide an extremely rapid response and low power consumption to meet fibre optic network requirements. We report the fabrication of Bragg gratings in polymer thin films containing a non-linear optical chromophore and their electrical tuning performance.

Films on the order of 10 μm thick were poled to align the chromophore and the electro-optic coefficient $r_{33}$ measured. Gratings were inscribed using the two-beam interference technique with periods on the order of 3 μm and thin film diffraction grating efficiencies of a few percent at the measurement wavelength. Higher diffraction efficiencies approaching 100% are expected for thin film waveguide structures. Measurements of $r_{33}$ in the vicinity of the grating showed an electro-optic effect several times greater than that of the solid-state standard electro-optic material LiNbO$_3$. A modulated electric field was applied to the sample and modulation of the grating efficiency measured with a lock-in amplifier. The grating efficiency was seen to be modulated by the applied electric field with a magnitude consistent with that expected from non-linear optical theory. Using the grating efficiency variation to infer $r_{33}$ gave a result in agreement with the optical measurement. The results indicate that under optimal conditions a maximum shift in the Bragg wavelength of a few nm/V could be obtained, with extremely fast response, which makes non-linear optical polymer thin films promising candidate materials for devices in present and future optic networks.