Faculty of Electrical Engineering & Computer Science
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Fabrication, characterization and investigation of the long term behaviour of integrated-optical waveguides in polymer substrates.

ABSTRACT - Masterthesis

There is no doubt about the fact that during the last decades, a significant revolution has occurred in the field of electronics. This electronic revolution arose from the combination of three technologies [1]:

- automated microfabrication of integrated electronic circuits
- semiconductor materials
- integrated electronic circuit design

Thus, it became feasible the mass manufacturing of low cost integrated circuits. "Light piping" was called the first optical waveguiding, which was achieved by Wheeler in 1880 [1]. He managed to transmit light through a glass pipe medium. Later on, with the advance of coherent optics and the laser invention, there was a huge demand for a long distance transmission medium. This medium, which is the latest evolution of the "light piping", is the worldwide mostly used optical fiber. One of the key materials which contributed to the above mentioned revolution was the polymer [1]. With the proper treatment, polymers are the perfect choice for photonic integrated circuits due to the fact that they exhibit wide controllability of the refractive index, high performance and tunability. In addition, their birefringence can be smaller when compared to the silica ones. They have also a low cost fabrication, high yields and they offer environmental stability [2].

Polymethyl methacrylate (PMMA) is a transparent thermoplastic material which is often used alternatively instead of glass because of its properties, easy processing and its low cost. However, it can be said that polymer waveguides have a lower reliability when compared with the glass ones. One disadvantage of polymer waveguides is the unstable UV-induced (ultra violet) refractive index profile at elevated temperatures. One of the reasons for the unstable behaviour of polymers is the diffusion controlled reactions of polymer molecules in the waveguide. In case the changes are too high, the waveguide loses its functionality.