Spectroscopic Characterization of Organic Films for Integrated Photonics Applications

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Integrated photonics makes possible today the realization of optical waveguide circuits with extremely high precision as well as a complex on-chip architectures[1-3] However, in most applications photonics requires integration with electronics to improve control and read-out operations, requiring a wide range of materials for light generation, processing, modulation and detection.[4] Organic molecular materials, offering flexibility, diversity and low-cost fabrication, can enrich conventional photonics platforms with new functionalities in order to develop next-generation photonic devices.

Solution processable organic semiconductors have been widely studied in the field of large-area, flexible and portable electronics.[5] These compounds together with soluble conductors and dielectrics enables the fabrication of complex organic devices solely through solution-based methods. Among these materials, poly{[N,N′-bis(2-octyldodecyl)-naphthalene-1,4,5,8-bis(dicarboximide)-2,6-diyl]-alt-5,5′-(2,2′-bithiophene)} (P(NDI2OD-T2)) constitutes a notable example of n-channel type polymeric semiconductor with high electron mobility. [10-11] However, few works report on the optical performance of fully printed organic semiconductors integrated in optical waveguides, and the integration itself of printed organic electronics on a photonic chip is stills a challenge.

In this work we investigate the optical properties of thin films of semiconductor polymers for their further incorporation into photonic integrated circuits (PICs) by mean of spectroscopic ellipsometry. It was determined the refractive index of thin films of organic semiconductors in the infrared region (1550 nm) using spectroscopic ellipsometry. Specifically P(NDI2OD-T2) presents a refractive index of 1.7 and k= 0.01 at 1550 nm. The tunability of the optical properties in the infrared region (1550 nm), after the application of an electric field to organic semiconductors thin films, is also demonstrated. Design and simulations of P(NDI2OD-T2)-SiON waveguides were performed based on the Beam Propagation Method, and it was further tested on home-made devices, making possible for the first time the direct incorporation of organic materials like P(NDI2OD-T2) into PICs.

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