Fabrication and Characterization of High Sensitivity Visible Light Photonic Crystal Biosensors

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We report the fabrication and characterization of improved Photonic Crystal (PC) biosensors operating in the visible region of the electromagnetic spectrum (instead of infrared) and based on a nanoporous low refractive index surface structure. These devices display a high degree of sensitivity to surface-specific bimolecular interactions and very low sensitivity to nonspecific bulk refractive index variations. Such properties are extremely attractive in a biosensor, as the Signal to Noise Ratio (SNR) is improved and consequently the detection resolution of the bio-assay is enhanced. Rigorous Coupled Wave Analysis (RCWA) is used to model the device and show that its superior characteristics arise from stronger confinement of evanescent electric fields close to its surface (Figure 1). Electron Beam Lithography (EBL) is used to fabricate a nano-structure 'mold' (Figure 2) from which nano-replicas are created using PDMS stamps at high throughput and low cost. The replicated nanostructures are coated with a high refractive index dielectric (TiO_2) to form the final device (Figure 3). Results of the Bulk Sensitivity and Surface Sensitivity of the device are reported and compared to devices operating in the same manner but in longer wavelength regimes.

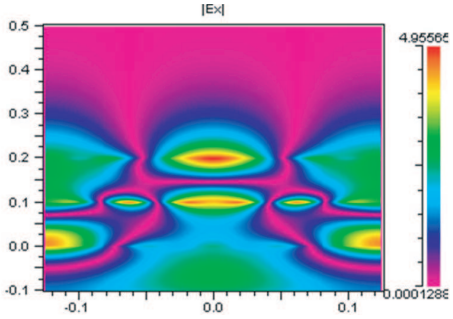

Figure 1: RCWA modeling results showing strongly confined electric fields at resonance.

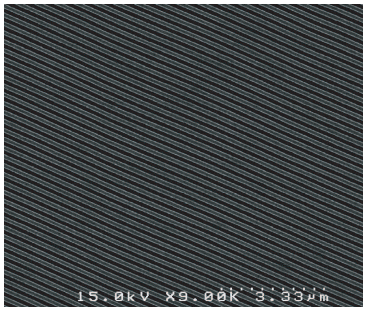

Figure 2: SEM micrograph of the surface structure of the 'mold' from which devices are made. The structure is comprised of linear features, with a period of 250 nm.

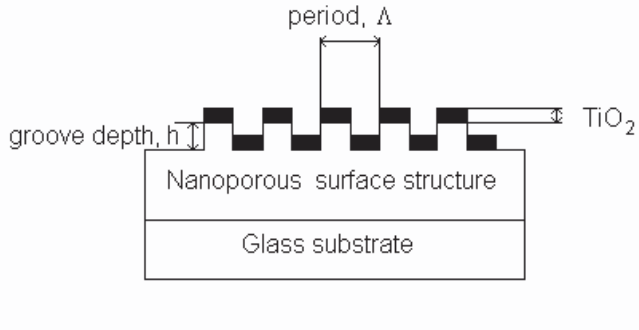

Figure 3: Cross section structure of the photonic crystal device. The resonance wavelength depends on the values of h, Λ and thickness of the TiO_2 layer.

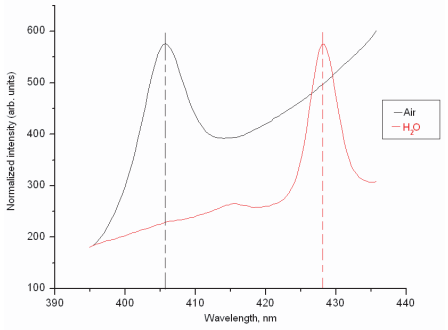

Figure 4: Normalized reflectance spectra shift of the PC device in air (black) and water (red) corresponding to a bulk refractive index change.