Feasibility of Optical Refractive Index Sensor based on Porous Anodized Aluminum Oxide and Nanocomposite of Diamond-like Carbon with Silver Nanoparticles: Simulations and Experiments

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Localized surface plasmon resonance-based sensors are an extremely active research field. The goal is to increase the sensitivity of the sensor and/or make it cheaper and easier to produce. In this work, we explore the possibility of a sensor based on a multilayered structure: aluminum substrate with porous anodized aluminum oxide (PAAO) and nanocomposite of diamond-like carbon with silver (DLC:Ag). First, aluminum is anodized in oxalic acid to grow PAAO. Then, a DLC:Ag nanocomposite is grown on top employing magnetron sputtering. The reflection spectra of the proposed structure were simulated employing the finite-difference time-domain (FTDT) method.

Fig. 1 (a) shows simulated reflection spectra at a 45° incidence angle of 290 nm thickness PAAO covered with 50 nm DLC:Ag mixture. Fig. 1 (b) shows the average experimental scattering spectra at a 60° incidence angle of 276±7 nm PAAO covered with 51±17 nm, 17±8 V.% DLC:Ag composite. Detailed descriptions of simulations and experimental setup can be found in [1] and [2], respectively.

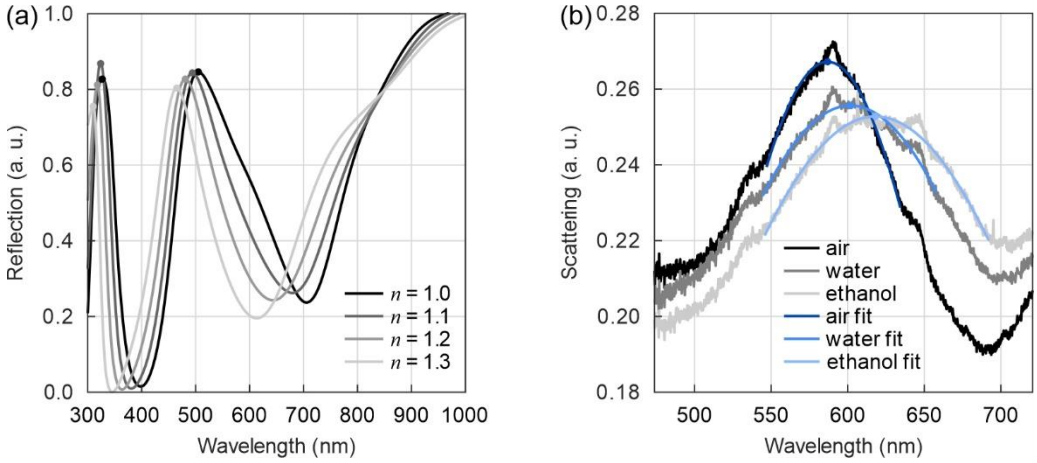

Fig. 1. Demonstration of optical sensitivity of porous anodized aluminum oxide covered with diamond-like carbon nanocomposite when immersed in different refractive index mediums: (a) simulation and (b) experiments. The experimental curves are fitted to the Gaussian function in the vicinity of the peak to better determine the peak wavelength.

Both simulations and experiments show the sensitivity of the optical spectrum depending on the refractive index of the surrounding medium: 133 nm/RIU ($R^2 = 0.99$) and 69 nm/RIU ($R^2 = 0.79$), respectively. Thus, optical sensors based on porous anodized aluminum oxide, diamond-like carbon, and silver nanoparticles are feasible. More experiments are needed to determine the optimal structure for the sensor and to perfect the deposition process.

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References

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