Artificial Opal/Photonic Crystal-based Gas Sensor Enabling Exhaled Breath Analysis and Alcohol Intoxication Detection

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Artificial opals, made of ordered silica particles, are Bragg's reflectors those structure favors condensation in pores that serves a core to the application in gas detection. However, following the first experimental manifestation, these materials demonstrated insufficient sensitivity, due to the limitation on the nanopores, and the stability of the analytical signal [V. N. Konopsky et al *Phys. Rev. Lett.* **2006**].

To address this problem, we present a new selective optical sensor system based on a porous monolayer of silica particles on a one-dimensional photonic crystal based on Ta_2O_5 / SiO_2 dielectric layers. First, we evaluated the influence of the physicochemical parameters of the medium and the adhesion/cohesion interactions between particles and photonic crystal surface on the formation of the artificial opal in the frame of dip-coating method. Second, we tested the sensing performance of the optimized artificial opals coatings.

Optimizing the parameters of dip-coating, we achieved the surface coverage of monolayer over a large area of more than 75%. Such a good layer, when used in sensor, enabled achieving detection of acetone, ammonia, ethanol, and isopropanol, biomarkers of human metabolism, at the level of 6 ± 2, 0.90 ± 0.05, 1.5 ± 0.3, and 3 ± 1 *kppm*, respectively. We developed a proof-of-the concept of alcohol intoxication analysis method using real breath samples with the subsequent protocol of time series analysis for an accurate evaluation of the degree of alcohol intoxication. These aspects open up new prospects for the future sensor application.

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