Novel approaches for dye insertion and stabilization in responsive mesoporous layer for sensor and display applications

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Abstract

For sensors or displays applications, the active elements play a critical role for device performances. For detectors, dyes, that are specifically responsive to a targeted analyte, can be deposited as a sensing layer on a surface. The response of the dye is then monitored optically by absorption or fluorescence changes depending on the concentration of the analyte. However, the way of stabilizing and encapsulating the dye on the surface is critical for detector performance, especially in terms of sensitivity and selectivity. In our patented approach, we used a combination of nanoparticles and sol-gel chemistry to generate hierarchically mesoporous layer, in which the dye is inserted. This hierarchically porous layer can lead to an increase of the linear response of the sensor over a wide range of concentration. Sol-gel chemistry is particularly interesting for a fine tuning of microporosity as depending on the choice of precursors, catalysts and curing conditions, a wide range of different microstructures can be generated. This leads to an increase in specific surface area but can also control the diffusion of the targeted species to the dye as well. This approach was used for oxygen and pH detection in different environments. In a following development stage, a full detector, composed of a LED illumination light, a read-out optical system and data acquisition system was built to interrogate the designed sensing layer. Detectors were used for detection of oxygen in air and in cell cultures and currently adapted to oxygen/pH detection in water in lakes and rivers as well as for oxygen monitoring on skin (transcutaneous) for biomedical applications. The long-term monitoring of these parameters remains a key to assessing the quality of water resources in the contract of global warming, or for the health monitoring.

In the second part of the talk, we will also show how this approach can be used for display applications and lead to an increase in luminescence. Here, specific dyes were arranged in the pores of the hierarchical layer in the form of J-aggregates. When combined with quantum dots (QDs), an increase of light re-emission could be observed through a FRET (Förster Resonance Energy Transfer) when the emitting film was exposed to LED light.