Printed luminescent chemosensor for detection of explosive or explosive-like molecules

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The role of nanoscience in analytical science has been greatly established for the development of chemical sensors with enhanced performance. The design of low-cost, easy-to-fabricate and portable analytical devices with a low limit of detection (LOD), good selectivity, high sensitivity and short response time are in high demand.[1,2,3] In this sense, chemical sensors based on fluorescent quantum dots (QDs) have attracted intense interest because of their excellent optical and electronic properties compared to the routinely employed fluorescent organic dyes.[4] These properties include size-tunable light emission over a wide range of energies, high photoluminescence quantum yield (PL QY), narrow emission line width, and good solution processability.[5] In addition, the physicochemical stability of QDs, their extremely large surface area, as well as the possibility of functionalizing their surface by conjugation with appropriate molecules make them very attractive nanomaterials for ultrasensitive sensors with the possibility of multiplex chemical detection.[6]

In this work, we have developed a novel CdSe QD-polymer-based luminescent chemosensor for the selective detection of explosive or explosive-like molecules. The sensor is based on an array pattern containing either green-emitting or red-emitting CdSe QDs in polycaprolactone (PC) as a polymer host matrix. Here, the sensor fabrication is performed by a microplotter, a direct printing technique based on ultrasonic fluid microdispensing to generate the nanocomposite patterning, resulting in accurate and high-resolution patterns. The transduction mechanism of the sensor is based on changes of the QD photoluminescence (PL) when molecules are adsorbed on the QD surface.

We evaluate the sensing capability of the nanocomposites by exposing the patterns to vapours of some high explosive or explosive-like molecules. Additionally, two different molecules such as 2-mercaptoethanol (MET) and ethylenediamine (EDA) are also tested for comparison. Remarkably, the change in intensity and response times for this two nanocomposites are quite varied depending upon the analyte to which it is exposed. The LOD of the sensors was determined to be as extremely low as 10^{-10} M for all analytes. Monitoring the changes in the fluorescence intensities of both nanocomposite patterns allows to pin-point each analyte on a two-dimensional (2D) map, where selectivity can be greatly enhanced.
We believe that this type of miniaturized luminescent QD-based nanocomposites might form the basis of a fully disposable sensing platform technology to perform effective chemical sensing and detection of many high explosive or explosive-like molecules among others.

References

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