

Colorimetric Visualization Using Polymeric Core-Shell Nanoparticles: Enhanced Sensitivity for Formaldehyde Gas Sensors

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Although equipment-based gas sensor systems (e.g., high-performance liquid chromatography) have been widely applied for formaldehyde gas detection, pre-treatment and expensive instrumentation are required. To overcome these disadvantages, we developed a colorimetric sensor based on polymer-based core-shell nanoparticles (P-CSNPs), which are inexpensive, stable, and exhibit enhanced selectivity. Spherical and uniform poly(styrene-co-maleic anhydride) (PSMA)/polyethyleneimine (PEI) core-shell nanoparticles were prepared and then impregnated with Methyl Red (MR), Bromocresol Purple (BCP), or 4-nitrophenol (4-NP) to construct colorimetric sensors for formaldehyde gas. The colorimetric response was maximized at a PEI/PSMA ratio of four, likely owing to the high content of amine groups. Effective formaldehyde gas detection was achieved at a relative humidity of 30% using the MR colorimetric sensor, which exhibited a large color change (92%) in 1 min. Advantageously, this stable sensor allowed sensitive and rapid naked-eye detection of low formaldehyde concentrations (0.5 ppm).