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Synthesis of reversible thermochromic polydiacetylene/zinc(II)/zinc oxide nanocomposites for colorimetric sensors

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A phenomenon that captivates interest is thermochromism, wherein certain materials undergo a change in color in response to fluctuations in temperature. Various materials, such as liquid crystals, conjugated polymers, and leuco dyes, exhibit thermochromic properties. These materials can undergo both reversible and irreversible color changes under specific temperature variations. Thermochromism has found extensive use in diverse fields like smart textiles, security printing, temperature indicators, and everyday decoration. Notably, the utilization of thermochromic pigments has seen a significant rise, particularly in their application as temperature indicators (thermometers) in decorative items. However, it is evident that, despite the array of alternatives available for monitoring temperatures using thermochromic materials, the adoption of this technology (or products integrating it) in the national market for detecting overheating in electrical devices has been lacking. Polydiacetylene (PDA), a type of conjugated polymer widely employed in detection applications, stands out due to its remarkable ability to exhibit colorimetric and fluorescent responses to various external stimuli. This polymer holds significant potential in various technologies, including colorimetric sensors, electrothermochromic displays, anti-counterfeiting materials, photodetectors, smart textiles, and smart paints/varnishes. In this study, we developed a straightforward method involving a simple mixture of PDA monomers and ZnO nanoparticles, followed by self-assembly, to create PCDA/Zn2+/ZnO nanocomposites that are sensitive to UVA. In this process, a thin film of DA monomers is obtained by the gradual evaporation of solvents. ZnO nanoparticles are dispersed in deionized water with the assistance of ultrasonication. The DA solution and ZnO aqueous suspension are mixed and subjected to extended ultrasonication at an elevated temperature. The resulting aqueous suspension of DA monomers is stored in a refrigerator (~4 ?C) overnight. UV light irradiation triggers topotactic polymerization, providing PDA assemblies with a blue color. We explore experimental parameters influencing the size and quantity of the nanocomposite, including incubation time, temperature, and solvent type. Additionally, we study the color transition behaviors of nanocomposites with controlled sizes. Our approach is simple and cost-effective, making it desirable for large-scale production.