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Reactive Oxygen Species (ROS)-Responsive Microgel for Biomedical Applications

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Reactive oxygen species (ROS) are indicators of oxidative stress in biological systems that should be monitored closely due to its great impact on physiological processes including signal transduction, gene expression and cell apoptosis. In addition, some of the ROS, like H_2O_2, are involved in many enzymatic reactions, and can be utilized to enable the detection of small molecular biomarkers like glucose and cholesterol, which cannot be detected easily using non-enzymatic approaches. In the present work, the ROS-responsive hydrogel microparticles, i.e. microgels, have been designed and fabricated. Microgel can protect the enclosed, ultrafine (diameters < 5 nm) ZnS nanoparticles (NPs) from dissolution; but the highly porous gel structure is permeable to the stable ROS like H_2O_2 which can rapidly react with the small NPs. The reaction releases free Zn^{2+} that can turn on the Zn^{2+} specific dye, Fluozin-3, and produce strong fluorescence. The reactivity towards ROS of the microgel can be tuned by changing the NP composition: adding a trace amount of Cu^{2+} can greatly enhance the fluorescence signal produced by H_2O_2, and permit detection of as low as 80 nM H_2O_2, lower than previously reported, fluorescence-based sensors. The excellent sensitivity towards H_2O_2 makes the ROS-responsive microgel a very useful tool for detection of glucose and cholesterol in human serum. When coupled with glucose oxidase and cholesterol oxidase, the sensor can achieve low limits of detection of 0.52 µM and 0.77 µM for glucose and cholesterol, respectively, which significantly reduces sample consumption. Our design of the ROS-responsive microgel is very unique and provides the advantages of simple and flexible fabrication, bright and stable signals, high structural stability, and rapid response towards stimulus, carrying high promise in biomedical applications.

Biography:

Dr. Wenwan Zhong is Professor of Analytical Chemistry at the University of California, Riverside. Dr. Zhong's research focuses on the development and application of microscale separation and sensors for biomarker discovery, functional study, and detection. Her current work covers three distinct areas: the use of microfluidics and flow field flow fractionation for analysis of circulating biomarkers; the use of capillary electrophoresis, mass spectrometry, and optical spectroscopy for assessment of the interaction between engineered nanomaterials and biomolecules; and the use of synthetic receptors for exploration of post-translational modifications in proteins.