Cerium oxide (CeO_{2-x}) nanoparticles for visualization of redox processes in biological systems

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Reactive oxygen species (ROS) such are indispensable for signal transmission and immune response in living cells. However, the concentration of ROS in the cell needs to be under strict regulation due to destructive effect of the most active types of ROS (such as ·OH) on the DNA and lipid membranes.

We have developed the new type of ROS sensor for biomedical applications based on Ce^{3+} luminescence of cerium oxide nanoparticles. Interaction with ROS (for, instance, with hydrogen peroxide) leads to $Ce^{3+} \rightarrow Ce^{4+}$ oxidation accompanied by quenching of Ce^{3+} luminescence of nanoceria. The decrease of Ce^{3+} luminescence after oxidant addition is determined by concentration of hydrogen peroxide (HP), and so the ratio between Ce^{3+} luminescence intensities before and after HP addition can be used for reliable detection of HP content. In contrast to traditional enzyme-based sensors, CeO_{2-x}-based luminescent ROS sensor is renewable and stable at long-term use.

Taking into account the well-known ability of cerium oxide nanocrystals to reversible ROS neutralization, the main importance of the obtained results lies in the possibility of nanoceria application as a new type of antioxidant nanoparticle with ability both to scavenge reactive oxygen species and to visualize the change in ROS concentration during this process. Cerium oxide nanoparticles can serve as a probe for reliable detection and long-term monitoring of ROS content. Such nanoparticles presents essentially a new type of nanodrugs for which the ability of distant control of their action presents key benefit in comparison with nano- and traditional medications of different kinds.