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Antioxidant properties of CeO2 nanoparticles produced by laser ablation

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Abstract

Antioxidant systems perform essential protective functions in living organisms. In this regard, cerium dioxide can be a promising antioxidant that works is due to the presence of a large number of surface structural defects, in particular, oxygen vacancies. The surface defects of ceria can effortlessly accumulate and release oxygen and also function as active centers for binding and neutralizing active oxygen radicals, which are usually fatal to living organisms. In this work, we studied the antioxidant properties of CeO2 nanoparticles obtained by laser ablation. The nanoparticles were obtained by ablation of a CeO2 target with the help of a nanosecond pulse laser of high intensity in the air. Particle sizes were monitored using transmission electron microscopy and small-angle X-ray scattering. X-ray diffractometry of samples annealed at temperatures up to 1200 °C indicates the high thermal stability of ablated nanoparticles. Electron Energy-Loss Spectroscopy, as well as luminescence spectra, indicate the presence of oxygen vacancy defects in the surface atomic layers of ablated nanoparticles. With decreasing particle size, the concentration of oxygen vacancies increases. The antioxidant properties of the nanoparticles in oxidative processes based on the Fenton reaction were studied. It was showed the nanoparticles with the smallest size have the highest antioxidant effectiveness. These results indicate prominent prospects for the use of the ablated nanoparticles in biological systems, where they can serve as highly effective antioxidant protectors.

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