P.S.I.E.10.

Hydroxyl radical scavenging activity of titanium oxide nanocrystals

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Titanium oxide nanocrystals (TiO_{2-x}) are well-known material due to its excellent photocatalytic properties. During the last years, some researchers have accidentally reported on the strong antioxidant activity of titanium oxide nanoparticles. However, the general role of titanium oxide surface defect structure in its redox activity is still a subject of discussions. In this report, we consider the role of the defect structure on redox properties of TiO_{2-x}.

Changing the amount of nitric acid as a catalyst and peptizing agent, we obtained two different types of titanium oxide nanocrystals with the same size, but different Ti^{3+}/Ti^{4+} ratio in the crystal lattice (which were confirmed by XPS measurements), and so, different reactive oxygen species scavenging properties. Both types of titanium oxide nanocrystals are characterized by quite good biocompatibility against red blood cells even at high concentration.

Electron donating properties and reactive oxygen species scavenging action of both types of titanium oxide nanocrystals against hydroxyl radicals (·OH) have been studied. Hydroxyl radicals are formed at water radiolysis during X-ray irradiation of the cell. Extremely high reactivity of ·OH radicals (average ·OH lifetime in the biological environment of only few nanoseconds) makes the task of its effective elimination by the internal systems of the living cell rather difficult. Hydroxyl radicals scavenging properties of obtained titanium oxide nanocrystals have been revealed to be directly related to Ti^{3+}/Ti^{4+} ratio being higher for the samples with higher Ti^{3+} content.

The efficiency of reactive oxygen species scavenging by titanium oxide nanocrystals in water solutions is close to that of nanoceria (CeO_{2-x} nanocrystals) of the same size suggesting that titanium oxide nanoparticles can be effective as an antioxidant in living cells as well. Moreover high biocompatibility of synthesized nanocrystals could be associated with their reactive oxygen species scavenging ability, which make them a prospective material for biomedical applications.