Interaction between Hydroxyapatite and Heavy Metals

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Abstract

The contamination of water and soil with heavy metals such as leadand cerium, is a major global problem. Lead affects the physiological functions of living organisms, cause cancer, and damage the immune system. Cerium is widely used in medicine for various applications such as catheters, burn treatment, and dentistry. Hydroxyapatite with the stoichiometric formula $Ca_{10}(PO_{4)6}(OH)_2$ could be a potential candidate for lead or cerium immobilization. This study focuses on the structural characterization of lead and cerium doped hydroxyapatite synthesized using two different methods: incipient wetness impregnation (IWI) and ion exchange under varying concentrations of Pb(II) and Ce(III). Characterization methods such as X-ray diffraction (XRD); Fourier transform infrared spectroscopy (FTIR); Scanning electron microscope (SEM) and Thermogravimetric Analysis (TGA) were used to understand the incorporation and/or the deposition of lead or cerium on the surface of calcined or uncalcined hydroxyapatite. The XRD spectra show that for powders doped with more than 0.6% Pb, characteristic peaks of PbO and $Pb(NO_3)_2$ appear respectively with the calcined and uncalcined powders prepared by the IWI method. XRD characterization showed the formation of $PbHPO_4$ and Pb-HAP for samples synthesized by ion exchange. These observations were approved by the results of the FTIR, SEM and TGA analysis. Indeed the results show that cerium is deposited on the surface of the hydroxyapatite in the form of cerium hydroxy nitrate $(Ce(OH)(NO_3)_2)$ for samples synthesized by IWI. However, the calcination of these samples led to the formation of CeO_2 confirmed by XRD spectra and SEM observations. In the case of samples synthesized by ion exchange cerium is efficiently hosted in hydroxyapatite under a solid solution at a low level (<3%) but forms isolated Ce-oxide at a high level (7, 10 and 15%). This work indicates the excellent insertion potential of lead or cerium ions in hydroxyapatite-based matrices suitable for various applications such as energy, biomedical, catalysis, and environmental sciences.

Keywords

Lead, Cerium, hydroxyapatite, incipient wetness impregnation, ion exchange.