Conventional electron paramagnetic resonance of Mn^{2+} in synthetic hydroxyapatite at different concentrations of the doped manganese

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Abstract. Powders of synthetic hydroxyapatite doped with Mn^{2+} ions in concentrations from 0.05 till 5 wt. % were investigated by conventional electron paramagnetic resonance (EPR). The parameters of the spin-Hamiltonian are derived. Partially resolved hyperfine structure in the magnetic fields corresponding to $g \approx 4.3$ and $g \approx 9.4$ is observed. The narrowing of the central peak with concentration is reported. A possibility to use the linewidth and intensity of the central peak for concentration measurements are discussed. The results could be used for the identification and qualification of Mn^{2+} in oil, mining and ore formations.

1. Introduction

Calcium phosphates (CaP) are the materials of the scientific and application interest due to their abundance in the nature and presence in the living organism. In nature, different calcium phosphate minerals are produced within a wide range of environments by geological (igneous apatite), geochemical and/or geomicrobiological (phosphorite), and biological (biological apatite) processes. Igneous apatite minerals nucleate and crystallize from molten, phosphate-rich rock, forming crystalline fluorapatite ($Ca_5[PO_4]_3F$), chlorapatite ($Ca_5[PO_4]_3Cl$), or hydroxyapatite ($Ca_{10}[PO_4]_6[OH]_2$, HAp or HA) [1]. The experimental results indicate that HAp/MnO_2 composite may be an effective adsorbent for the removal of lead ions from aqueous solutions [2], while the HAp supported manganese could serve as precursor for the oxide catalysts [3].

Manganese is essential impurity element in CaP. Oil containing formation – rock, sands or bitumen very often possess impurity manganese [4]. One of the powerful experimental methods for identification of manganese, especially in 2+ state (Mn^{2+}) in different types of materials (including apatites) and characterization of structure of their complexes is electron paramagnetic resonance (EPR) [4-16]. Despite the large number of the studies performed, many important problems relating to anionic and cationic substitutions in HAp are not sufficiently investigated. Moreover, data of different studies are contradictive. The most contradictive information is associated with the sites of the ions localization in biomineral, synthetic and nanosized samples.