SYNTHESIS AND MICROSTRUCTURAL PROPERTIES OF MIXED IRON-GALLIUM OXIDE NANOPARTICLES

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Abstract

Iron and gallium oxides have been intensively investigated in the last years due to their specific properties, which are suitable for a number of advanced applications (magnetic materials, catalysts, photocatalysts, photoanodes, gas sensors, luminescent materials, etc.). These properties can be improved or tuned by modification of the particle size and shape, as well as by incorporation of foreign cations into their structure. Due to the same charge and a similar ionic radius, Fe_{3+} and Ga_{3+} have a high potential for mutual substitution in the oxide structure. Mixed Fe-Ga oxides were prepared by calcination of mixed Fe-Ga oxyhydroxide precursors (-Fe1-xGaxOOH, 0 x 1) at 500 or 1000 °C. Isostructural oxides -Fe_2O_3 (hematite) and -Ga_2O_3, as well as their solid solutions -Fe2-xGaxO3 (x = 0, 0.4, 1, 1.6, 2) were prepared by calcination at 500 °C. An increase in Ga content in -Fe_2-xGa_xO_3 caused a reduction of the unit-cell, a change of the particle shape and size, a reduction of the hyperfine magnetic field, a shift in the position of IR bands to higher wavenumbers, and a decrease in intensity of all absorption bands in the UV-Vis-NIR spectra. Calcination of the Fe-Ga oxyhydroxides at 1000 °C resulted with the formation of a rhombohedral -Fe_2-xGa_xO_3 phase for x = 0 and 0.4, an orthorhombic $GaFeO_3$ phase for x = 1 and a monoclinic -Ga_xFe_2-xO_3 phase for x = 1.6 and 2. Monoclinic -Ga1.6Fe0.4O_3 phase showed two strong luminescence peaks in the blue region of the PL spectrum.

Keywords: Hematite, α-Ga_2O_3, β-Ga_2O_3, $GaFeO_3$, Mössbauer spectroscopy, XRD, FE-SEM, FT-IR, UV-Vis-NIR, PL

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