PHYSICOCHEMICAL PROPERTIES OF $Mg(Al_xCr_{1-x})_2O_4$ SOLID SOLUTIONS PREPARED VIA SOLUTION COMBUSTION

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Materials based on magnesium, aluminum, and chromium oxides possess high thermal stability, mechanical strength, and catalytic activity, making them promising for the development of the high-temperature catalysts and refractory coatings. The aim of this work was to investigate the influence of the aluminum-to-chromium ratio and the type of the organic fuel on the physicochemical properties of $Mg(Al_xCr_{1-x})_2O_4$ solid solutions.

Sample synthesis (x = 0; 0,25; 0,5; 0,75; 1) was performed via the solution combustion method using metal nitrates in a stoichiometric ratio with the fuel. Glycine, citric acid, and tartaric acid were employed as reducing agents. The structure and morphology of the obtained materials were characterized using IR spectroscopy (IRTracer-100) in the wavenumber range of 350–4000 cm^{-1}, scanning electron microscopy (VEGA3 TESCAN), and elemental microanalysis.

Different fuel types and variations in the aluminum-to-chromium ratio in significantly affect the porosity and crystallite shape of the synthesized materials. When using glycine, which is characterized by a high combustion temperature, a spongy, highly porous structure is formed due to rapid gas release. An increase in chromium content results in a transition to a fine-grained dense structure.

IR spectra analysis showed that the most pronounced characteristic bands of the spinel structure (420–480 cm^{-1}) appeared in $MgCr_2O_4$ synthesized with glycine. When aluminum content in $Mg(Al_xCr_{1-x})_2O_4$ solid solution was increased, the intensity of the M–O bond vibration bands decreased and they broadened. It is connected to the reduction in the crystallinity of the spinel phase and an increase in the amorphous degree of the samples. In all IR spectra weak vibrations of adsorbed water and surface-coordinated carbonate groups (1320–1510 cm^{-1}, 1030–1080 cm^{-1}) appear; the splitting of the asymmetric stretching vibration of the carbonate ion is observed (~1400-1510 cm^{-1} and ~1310–1340 cm^{-1}). The intensity of these vibrations is significantly lower for mixed-composition solid solutions. The shape and intensity of the vibrations depend on the fuel type.

Thus, the type of the fuel influences the porosity and the crystallite shape through variations in gas evolution intensity and reaction temperature. Varying the composition in $Mg(Al_xCr_{1-x})_2O_4$ solid solution and fuel type allows for the controlled adjustment of the morphological parameters of the spinel.

1. Ilhan, S. Synthesis and characterization of $MgFe_2O_4$ nanoparticles prepared by hydrothermal decomposition of co-precipitated magnesium and iron hydroxides. / S. Ilhan, S. G. Izotova, A. A. Komlev // Ceramics International. – 2015. – V. 41. – P. 577-585.