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Influence of Al^{3+} doping on structural, magnetic, elastic and adsorption properties of $MgFe_2O_4$

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Sol-gel auto-combustion synthesis is a novel technique for prepearing the materials with ultra fine particles using an exothermic reaction between metal nitrates and an organic fuel. The goal of this study is to evaluate the influence of the mixture of alanine and glycine fuels on the synthesis of magnesium ferrite-aluminates $Mg_A[Fe_{2-x}Al_x]_BO_4$ ($0 \le x \le 2$ with step 0.2) by sol-gel auto-combustion reaction. Ferric nitrate, aluminium nitrate and magnesium nitrate powders in the molar ratio of (Fe+Al)/Mg=2 were dissolved in distilled water. A mixture of fuels were added for the formation of metallic complexes. The solution was heated on a hot plate. After drying, all samples ignited automatically. The morphology and magnetic properties of the as-obtained powders were investigated. The powders were characterized by X-ray diffraction (XRD), nitrogen adsorption (BET), scanning electron microscopy (SEM), energy-dispersive analysis (EDS), Fourier transform infrared spectroscopy (FT-IR), vibrating sample magnetometer (VSM) technique. The samples presented only the formation of crystalline and monophases $Mg(Fe,Al)_2O_4$. The average crystallite sizes of the samples were in the range of 48 to 51 nm, which was confirmed by Scherer's formula. The IR spectra indicate the presence of Me-O stretching band characteristic of spine ferrite, thus confirming the formation of spinel structure. The lattice constants, *a*, obtained from the XRD result, range from 0.838 nm (for $MgFe_2O_4$) to 0.808 nm (for $MgAl_2O_4$). The larger *a* value for the x=0 could be due to the larger ionic radius of Fe^{3+} (0.0645 nm) in comparision with ionic radius of Al^{3+} (0.0535 nm). The cation distribution of $MgFe_2O_4$ is likely to be partially inversed, while the cation distribution of $MgAl_2O_4$ is likely to be normal. The force constants K_t and K_o for the two sites have been deduced from IR band frequencies and compared with the trend of bond lengths: K_T increases (from 1.659 to 2.489 dyne/cm^2) because the bond length M_A-O decreases, and K_O also increases (from 0.943 to 1.309 dyne/cm^2) because the bond length M_B-O decreases with increasing Al^{3+} content. The samples were proposed as the sorbents for AO7 dye removal from the aqueous solutions. For the first time antistructural modeling of the surface active centres of the magnesium ferrite-aluminates system is considered.