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Structural, vibrational and dielectric behavior of $Co_{1-x}M_xCr_2O_4$ (M = Zn, Mg, Cu and x = 0.0, 0.5) spinel chromites

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Abstract:

Low temperature sol-gel auto combustion method is used to synthesize the spinel chromites of $Co_{1-x}M_xCr_2O_4$ (M = Zn, Mg {non–Jahn Teller (JT) ion}, Cu {JT ion}; x = 0.0, 0.5). Synchrotron, and lab x-ray diffraction pattern confirms the single-phase crystalline nature. Structural features from cubic (space group $Fd3m$) [$CoCr_2O_4$, $Co_{0.5}Mg_{0.5}Cr_2O_4$ and $Co_{0.5}Zn_{0.5}Cr_2O_4$] to tetragonal (space group $I4_1/amd$) [$Co_{0.5}Cu_{0.5}Cr_2O_4$] are reported. SEM micrograph of sintered samples results in less porosity with average particle size distribution of ~ 0.2 – 0.3 μm. Shifting of Raman active phonon modes is seen with doping and an additional Raman active mode is seen at 666.45 cm^{-1} for $Co_{0.5}Zn_{0.5}Cr_2O_4$. Dielectric behavior as a function of frequency reveals that dispersion in all these chromites is attributed to hopping mechanism. Higher value of dielectric constant (ε') and minimum loss tangent (tan δ) for non-JT ion $Co_{0.5}Zn_{0.5}Cr_2O_4$ is measured inferring effective charge polarization in chromites as compare to doped JT ions. Both grains and grain boundaries are active in $Co_{0.5}Zn_{0.5}Cr_2O_4$ at lower frequencies as depicted from impedance analysis. Doping does not showed the presence of electric polarization in chromites.

Keywords: Spinel chromites, Synchrotron x-ray diffraction, Raman scattering, Dielectric properties.

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