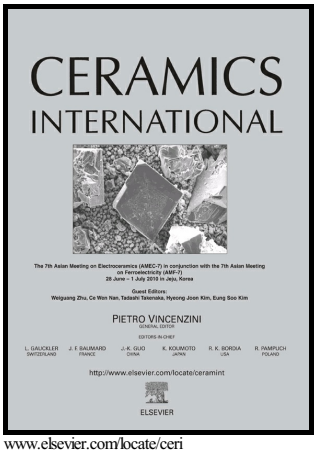

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Structural, morphological and optical changes in periodic fractal nanosymmetries of Ni doped chromium oxide ceramic nanostructures

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Abstract

Undoped and Nickel doped chromium dioxide (Ni^{+2}:Cr_2O_3) bulk ceramic nanostructures were prepared by standard solid state reaction method. We have studied the structural, surface morphological and optical properties of samples using X-ray diffraction (XRD), Raman spectroscopy, and Scanning electron microscopy coupled with Energy Dispersive X-ray spectroscopy (SEM/EDX), and Photo luminescence (PL). This study is based on the idea that main factors influencing the disorder in structural and morphological properties of compounds are the radius, valency and charge mismatch of the substituent which plays a critical role in the growth of nanostructured ceramics. X-ray diffraction results reveal rhombohedral crystal structure with peak broadening and shoulder indicating the successful incorporation of Ni upto 5wt % doping. Raman results exhibited shift in vibration modes associated with Cr_2O_3 due to Ni content. The strongest band at 551 cm^{-1} is of A_{1g} symmetry, the others with E_g symmetry were observed in all NCO samples. The presence of transition metal ions introduced blue shift for 353 cm^{-1} mode in NCO-3% while red shift for 556 cm^{-1} mode in NCO-1% sample. Dynamical architectural changes in fractal type nanotriangles and nanosheets were observed in the SEM micrographs of Ni doped chromium oxide ceramics. Nanodiamond like octahedrons were also observed in 10 wt.% Ni doping ratio which resulted from periodic arrangement of Sierpinski triangles. EDX results revealed that only Cr, O and Ni were present in the samples with dominance of oxygen while proportion of Cr, Ni and O constituents in each sample were not stiochiometric. PL results show dominant violet-blue emission was appeared at 416 nm and 437 nm and at around 450 nm to 600 nm broad band emission occurred. The highest PL intensity for NCO-4% is attributed to the defects and metamorphic growth related to appearance of new symmetries, nano Sierpinski triangle and nano sheets.

Keywords: Doping; Sintering Kinetics; Ceramic composite & particles; Fractal symmetries