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Effects of size and Cr substitution on the structural and magnetic properties of α–CoV2O6

α–CoV_2O_6 is a well-investigated one-dimensional spin chain system [1–4]. Most of the studies are focused on bulk polycrystalline and single-crystalline α–CoV_2O_6. The compound orders antiferromagnetically below 15 K [2] and has been shown to exhibit field-induced metamagnetic transitions below T_o. This study investigates how the structural and magnetic properties of this compound are influenced by size reduction and the presence of antiferromagnetic (AFM) Cr ions. Thus, structural and magnetic properties of Cr substituted powder α–CoV_2O_6, prepared using a wet chemical synthesis method, are presented. Most of the samples were calcined at 500 ℃, while the α–CoV_2O_6 sample was calcined at 450 ℃ in order to study the effect of size reduction. Temperature-induced size reduction of α–CoV_2O_6 was confirmed using transmission electron microscopy (TEM) analysis. The average particle size of Cr substituted samples decreases with increasing Cr wt.%. Elemental concentrations were confirmed using energy dispersive spectroscopy (EDS). X-ray diffraction (XRD) studies show that all samples have a single phase. Average crystallite sizes, lattice parameters, and bond angles were calculated using Williamson-Hall [5] and Rietveld refinement [6]. These data revealed minor changes in these parameters with size reduction and Cr substitution. Temperature, field, and time dependence of magnetization, M(T), M(μ_0H), and M(t), respectively, measurements were performed to explore the magnetic properties. Zero-field cooled (ZFC) and field cooled (FC) M(T) data at 0.1 T revealed an antiferromagnetic ordering below T_o = 16 K. An enhancement of AFM was observed with size reduction and Cr substitution in M(T) data below 5 K in the form of an increase in magnetization. Increasing field strength to 2.5 T causes a shift in T_o and a spin-glass-like irreversibility occurs at T_s between ZFC and FC curves which persist even at 5 T. Spin-glass-like freezing behavior at low temperatures was confirmed by M(t) data. M(μ_0H) isotherms revealed a three-step metamagnetic transition below T_o from a low field AFM state to a high field ferromagnetic (FM) state through an intermediate state. The stability of the steps depends strongly on temperature. A sizeable hysteresis with remanence magnetization was observed for M(μ_0H) isotherms measured below 5 K. Finally, the study provides direct observations of the coexistence of multiple magnetic states in powder α–CoV_2O_6. The dependence of structural and magnetic properties on Cr substitution and size will be discussed.

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Apply to be considered for a student ; award (Yes / No)?

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