INDIAN INSTITUTE OF TECHNOLOGY GUWAHATI
SHORT ABSTRACT OF THESIS

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SHORT ABSTRACT

The concept of geometrical frustration in magnetic spinels provide an intriguing platform for the scientists to understand the magnetic exchange interactions at the fundamental level. Such, frustration in spin systems give rise to unique ordered states together with the several novel physical phenomena such as multiferroics, reentrant spin-glass behavior, quantum spin-liquid state, anomalous Hall effect, sign reversal exchange bias, giant magneto-caloric effect and canted ordering. Recently, spinel oxides have attracted considerable interest due to their numerous technological applications and the competing magnetic interactions between the magnetic spins. In this thesis work an attempt was made to understand the crystal structure and magnetic properties of few Antiferro/Ferrimagnetic Pyrochlore Spinel oxides by means of neutron scattering and magnetization measurements. We establish the magnetic ground state of normal spinel $GeCo_2O_4$ with effective spin S = 1/2 and g = 6.155 from the temperature dependent dc-magnetic susceptibility using the modified Curie–Weiss law, which satisfy both the saturation magnetization value obtained from the field dependent magnetization data as well as the neutron diffraction data. Also, we determined the dominant FM exchange coupling exchange constant J_1/k_B = 14.7 K between the neighboring Co^{2+} spins arranged in the Kagomé and Triangular planes and established the H-T phase diagram which shows the temperature variation of three critical fields identified from the magnetic hysteresis loops. Furthermore, the band structure analysis and density of states obtained from the first principle calculation based on DFT+U of $GeCo_2O_4$ system are in good agreement with the direct energy band-gap E_g = 3.156 eV determined from the diffuse reflectance spectroscopy. Besides, we present the Jahn-Teller distortion, canting spin arrangement, and magnetic compensation behavior of Manganese diluted $TiCo_2O_4$ inverse spinels by the temperature dependent neutron diffraction and magnetic susceptibility measurements. Moreover, the analysis of dynamical scaling laws to the ac-susceptibility data indicate the co-existence of reentrant spin-glass phase together with the Ferrimagnetic long range ordering of these compounds. Analysis of these results demonstrate that both compounds exhibit noncollinear spin arrangement $++--$ and $+-+-$ below the ferrimagnetic Néel temperature (T_{FN}) which represents the existence of additional antiferromagnetic component lying perpendicular to the ferrimagnetic component. Furthermore, we have also explored the low-dimensional nanostructures of Cu and Zn diluted $MnCo_2O_4$ with the special emphasis on the dilution effects on the exchange interactions and magnetization dynamics. The x-ray photo electron spectroscopy and the Rietveld analysis of x-ray diffraction patterns confirm the phase purity and the cationic distribution of these nano-crystallites. The dc-magnetic susceptibility measurements reveal the presence of ferrimagnetic ordering of these nanoparticles below T_{FN}. A significant change in the exchange interactions due to dilution can be observed from the Néel fitting analysis of high temperature inverse susceptibility data. Additional measurements of ac-susceptibility ($\chi_{ac}(T)$) data confirm the presence of spin-glass phase of these nanoparticles.