Proc. of the Intl. Conf. on Nanotechnology for Better Living, 2016
Editors K. K. Kar, A. Shah and R. Sharma
Vol. 3, No. 1, p. 134
doi:10.3850/978-981-09-7519-7nbl16-rps-134

Effect of Zn doping on the physical properties of multiferroic $Cu_2V_2O_7$

Bidisa Chattopadhyay[1*], Md. A. Ahmed[2], S. Bandyopadhyay[2,3] and P. Mandal[4]

[1]LadyBrabourne College, P1/2 Suhrawardy Avenue, Kolkata – 700 017, India
[2]Department of Physics, University of Calcutta, 92 A.P.C. Road, Kolkata 700009, India
[3]CRNN, University of Calcutta, JD 2, Sector III, Salt Lake, Kolkata 700098, India
[4]Saha Institute of Nuclear Physics, 1/AF Bidhannagar, Kolkata – 700 064, India
*Email: bidisa_chattopadhyay@rediffmail.com

Multiferroic compounds have attracted considerable attention in recent past due to the coexistence of magnetism and ferroelectricity as their order parameters are coupled [1]. Copper based divanadate $Cu_2V_2O_7$ in its low temperature stable α-phase transforms into a canted antiferromagnetic state below 34K (T_N) giving rise to a ferromagnetic ground state due to Dzyaloshinskii-Moriya (DM) interaction. In this work, we have studied the effect of transition metal Zn doping on the physical properties of $Cu_2V_2O_7$ through x-ray structural, magnetic and dielectric measurements. We have prepared a series of polycrystalline $Cu_{(2-x)}Zn_xV_2O_7$ samples for $x = 0.0, 0.05, 0.1, 0.15, 0.2$ *and* 0.3 by solid state reaction method. Zn mediated polymorphic phase transition from α-$Cu_2V_2O_7$ to β-$Cu_2V_2O_7$ phase beyond x=0.15 is observed from x-ray structural studies (Figure 1).

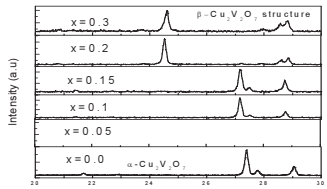

Figure 1: XRD patterns for 2θ in the range 20° to 30°

Temperature dependent ZFC(zero field cooled) and FC(field cooled) magnetization data (Figure 2) show a steep upturn as the temperature lowers indicating a transition to a magnetically ordered state which continues up to Zn concentration *x*=0.15. Moreover, field dependence of magnetization (M(H)) behavior (Figure 3) show hysteresis for x=0.0,0.1 and 0.15 samples below T_N which is absent for all other samples. This result confirms the idea that the undoped compound $Cu_2V_2O_7$ as well as $Cu_{(2-x)}Zn_xV_2O_7$ up to x=0.15, are antiferromagnetic with canted spins leading to weak ferromagnetism which is absent beyond x=0.15 in the β-phase.The Curie-Weiss fit ($\chi(T) = \frac{C}{T-T_\theta}$) of the inverse susceptibility versus temperature curve in the high temperature region show negative values of T_θ for all the samples.

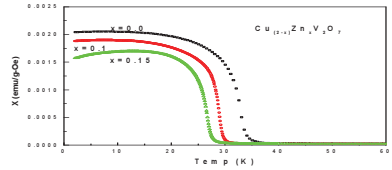

Figure 2: Magnetic susceptibility of $Cu_{(2-x)}Zn_xV_2O_7$

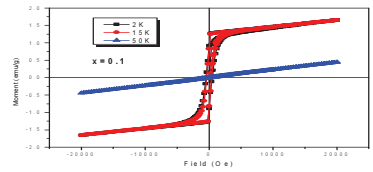

Figure 3: M(H) curve for x=0.1 sample

We have calculated the values of the transition temperatures T_N and effective magnetic moment μ_{eff} from the Curie-Weiss fit. T_N as well as μ_{eff} gradually decreases with Zn concentration which is expected since nonmagnetic Zn dilutes the spin of the samples. Temperature variation of the real part of the complex dielectric permittivity (ϵ') measured at frequencies up to 20 KHz for x=0.0 and 0.1 samples show a small humplike anomaly around T_N. Such an electric anomaly around magnetic transition establishes $Cu_2V_2O_7$ as a promising multiferroic compound. No significant frequency dispersion found in these materials may be related to some long range electric order [2].

References

1. T. Kimura et al., Nature **426**, 55 (2003).
2. J. Sannigrahi etal. archive 1501.00809v2