Magnetic suscetibility studies of the $(Cr_{84}Re_{16})_{100-x}V_x$ alloy system

BS Jacobs,[1] ARE Prinsloo,[1] and CJ Sheppard[1]

[1] *Cr Research Group, Department of Physics, University of Johannesburg, Auckland Park, Johannesburg 2006, South Africa*

The temperature dependence of magnetic susceptibility, $\chi(T)$ is a suitable measurement in determining the magnetic ordering temperature, obtaining information regarding density of states [1], as well as to detect the presence of localised moments [2]. In accordance with previous studies on $Cr_{100-u}Re_u$ alloys [3], $\chi(T)$ measurements of the $(Cr_{84}Re_{16})_{100-x}V_x$ alloy system exhibit anomalies at Néel temperature T_N associated with the onset of the antiferromagnetic (AF) spin-density-wave (SDW) state. These anomalies become more pronounced as x increases. T_N determined from $\chi(T)$ measurements are in close agreement with T_N obtained from the measurement of temperature dependence of electrical resistivity, $\rho(T)$. Prominent broad deep minima are observed in $\chi(T)$ upon cooling below 100 K followed by low temperature upturns for samples with $x = 10.9$ and $x = 12.4$ which may be attributed to a Curie tail arising from oxide impurities [4]. A second anomaly, not associated with T_N, but having the same trend, is observed at a temperature $T_o < T_N$ for alloys with $x = 0$, 1.3, 2.4, 4.4, 5.7 and 6.9. T_o observed in the $x = 0$ alloy has value 309 $\pm$ 2 K which is very close to 308 K, the transition temperature of AF Cr_2O_3 [5]. The presence of Cr_2O_3 was confirmed using neutron diffraction study of the $Cr_{84.7}Re_{15.3}$ alloy [6]. However, the value of T_o obtained from $\chi(T)$ decreases with an increase in x indicating that the oxide is most likely a V doped oxide of Cr having the formula $(Cr_{100-\delta}V_\delta)_2O_3$. x dependence of T_N obtained from $\rho(T)$ and $\chi(T)$ measurements were fitted with a power law yielding $x_c = 10.47 \pm 0.03$, the critical concentration at which antiferromagnetism (AFM) disappears. It is therefore evident that the low temperature upturns for samples with $x = 10.9$ and $x = 12.4$ is associated with the $(Cr_{100-\delta}V_\delta)_2O_3$ oxide. Curie-Weiss (CW) behaviour in the $(Cr_{84}Re_{16})_{100-x}V_x$ alloy system was tested by plotting χ^{-1} as a function of T and fitting the CW equation [2] to the experimental data above T_N. A positive gradient of the fit confirms CW behaviour [7] which was observed in the $x = 5.7$, 10.4, 10.9 and 12.4 alloys suggesting the existence of local moments at $T > T_N$.

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