# Magnetism in $RMn_4Al_8$ (R=Sc,Sm, Tb, Dy and Ho) compounds: Possible role of Mn

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**Abstract**

The ac magnetic susceptibility, electrical resistivity and thermoelectric power results of $RMn_4Al_8$ compounds are discussed. The compounds with magnetic rare earths order antiferromagnetically at low temperatures. Electrical transport is dominated by electron-phonon scattering at high temperatures. The magnetism in these compounds can be explained in terms of the Mn site occupancy and the Mn-Mn distances along c-axis

*Key words:* Rare earth intermetallics; Magnetic properties ;Electrical transport ;

## 1. Introduction

Extensive studies on $RT_4Al_8$ (R = Rare earth, T = Transition metal) compounds indicate a wide variation in the magnetic behaviour of the rare earth and 3d transition elements [1]. Though the rare -earths order antiferromagnetically below, say, 30 K, the 3d elements behave differently. Fe in RFe4Al8 has a localized moment (effective moment of 4.4 mB) and orders independently of the rare earth sublattice. Mn in $RMn_4Al_8$ has also a localized moment ( 1 mB) but orders only when the rare earths order. Cr in $RCr_4Al_8$ has no moment of its own, but it has an induced moment by its magnetic rare earth neighbours. Cu in $RCu_4Al_8$ is nonmagnetic. This nature of 3d elements in the RT4Al8 compounds led to a series of investigations.

## 2. Experimental

The said compounds were prepared by electric arc melting under argon atmosphere starting from stoichiometric elements and vacuum annealed for a span of 10 days at 1073 K. They were characterized by X-ray diffraction experiments at room temperature and ac magnetic susceptibility, electrical resistivity and thermoelectric power measurements were carried out.

## 3. Results and Discussion

The X- ray diffractograms obtained at room temperature reveal the single phase nature of the samples with Bragg peaks conforming to the cubic $ThMn_12$-type structure. The lattice parameters vary according to lanthanide contraction. The ac magnetic susceptibility plots of the $RMn_4Al_8$ compounds are shown in Fig.1. All compounds with magnetic rare-earths show a typical para- to antiferromagnetic transition at low temperatures. ScMn4Al8 does not show any transition down to 4.2 K. The electrical resisitivity is metallic

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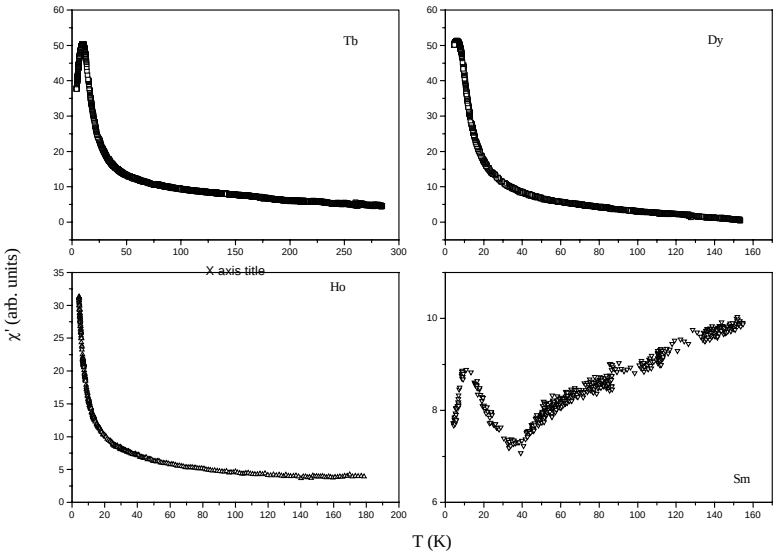


Fig. 1.

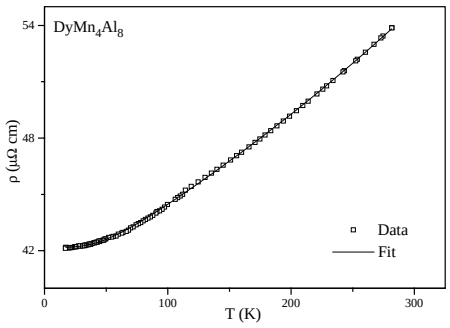


Fig. 2.

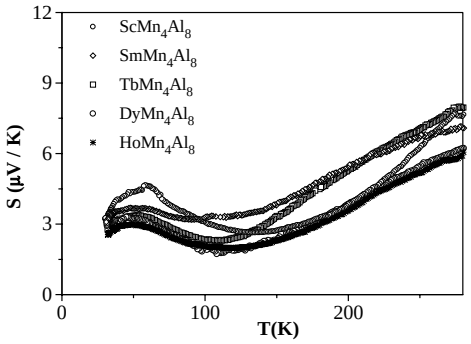


Fig. 3.

and the data for $DyMn_4Al_8$ is shown in fig.2 for reference. Electrical resistivity has a small, but appreciable electron - electron scattering contribution at low temperatures and it follows the conventional Bloch - Gruneisen expression explaining the electron - phonon scattering at high temperatures. The Debye temperature values obtained from the fit are comparable with that of $RMn_4Al_8$ (R = La and Y) compounds[2]. Thermopower of these compounds has a linear dependence on temperature above 150 K and exhibit a phonon drag-like feature at low temperatures[Fig.3]. The magnetic behaviour of $RMn_4Al_8$ (R = Sm, Tb, Dy and Ho) compounds is attributed to the Mn-Mn interactions along c-axis, forming 1-D like spin chains as well as to the site interchange between Mn and Al atoms.

## References

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