MAGNETIC PROPERTIES AND MAGNETOCALORIC EFFECTT ON $GdCo_{1.8}M_{0.2}$ with M=Al, Cu, Ni

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1. Introduction

In this work, the structural, magnetic properties and magnetocaloric effect of $GdCo_{1.8}M_{0.2}$ with M = Al, Cu, Ni were investigated. The X-ray analysis showed that all these compounds are single phase and crystallize in the cubic $MgCu_2$ (C15) structure. The Gd occupies -43m sites while Co and Ni are distributed in -3m positions.

2. Experimental Setup

The magnetic properties were studied in external magnetic fields up to 12 T and a large temperature range 4.2 – 650 K. All of the samples are ferrimagnetically ordered, the Gd and Co magnetic moments being antiparallely oriented. The ferrimagnetic-paramagnetic transition temperatures are few tens of degrees above room temperature. As example, the Curie temperatures, T_C, are 378 K for M=Cu, 384 K (M=Al) and 332 K (M=Ni). The saturation magnetizations are higher than in the parent compound, being 5.24 μ_B/f.u. in the compound with cooper and 5.29 μ_B/f.u for M =Ni. Assuming that the magnetic moment of gadolinium is 7 μ_B/atom, we have determined the cobalt magnetic moments, M_{Co}, at 4.2 K. The M_{Co} are little dependent on composition, $M_{Co} = 0.94 \pm 0.3$ μ_B/atom. It was shown that in $GdNi_2$ compound Ni atoms show a very weak or null magnetic contribution. Band structure calculations performed on $GdNi_2$ show that there is a small magnetic moment of 0.12 μ_B/atom on Ni while from magnetic measurements a null magnetic moment is suggested [1]. The replacement of Co by M atoms modified the exchange interactions. When cobalt is substituted by M atoms a *p-d* type hybridization appear. Due to this hybridization the electronic configuration of cobalt *d* band is modified and consequently the magnetic moment

3. Results

The magnetization isotherms and Arrot plots for the samples with M = Cu measured around the transition temperatures are shown in Fig.1. From the Arrot plots we can see that these compounds undergo a second-order magnetic phase transition at the Curie temperature. Similar behaviours were found for all of the investigated samples. The magnetocaloric effect was also studied. Fig.1. show the magnetic entropy change, ΔS_M, as a function of temperature for different magnetic field changes for the compounds with M = Ni. The $\Delta S_M(T)$ peaks are broad and have a symmetrical shape, a behavior which is characteristic for materials exhibiting a second-order magnetic phase transition [2]. As example, for a magnetic field change from 0 to 4 T, the obtained maximum entropy change values are 2.81 J/kgK for (M = Cu) to 3.08 J/kgK (M = Ni). The magnetic entropy changes versus temperature plots in applied field changes of 0-4 T and 0-2 T respectively for M = Ni sample are presented in Fig.1. The relative cooling power are rather high, being 157.36 J/kg for M = Cu and 215.6 J/kg for M = Ni. Due to their high *RCP* values these compounds are promising candidates for applications in magnetic refrigeration devices just above room temperature range.

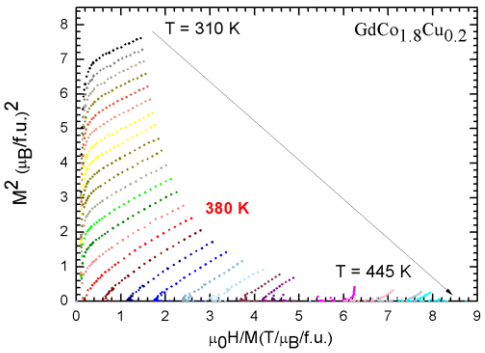

Fig. 1. Honda Arrot plots and the temperature dependences of magnetic entropy change for $GdCo_{1.}Cu_{0.2}$.

4. Conclusion

From the results we can conclude that the $GdCo_{1.8}Ni_{0.2}$ is the optimum sample which could sustain a magnetic refrigeration cycle through the application of the magnetocaloric effect around room temperature (approx. 40° C).

5. References

[1] E. Burzo, A. Chelkovski, H. R. Kirchmayr, Landolt Börnstein handbuch, Vol. 19 d2, Springer Verlag, Berlin, 1990.

[2] J. Lyubina, O. Gutfleisch, M. D. Kuz'min, and M. Richter. J. Magn. Magn. Mater., 320 (18):2252 - 2258, 2008.