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# Thermoelectric Power of Gd<sub>4</sub>(Co-A)<sub>3</sub> Compounds (A = Cu, Pt)

## Abstract:

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**Thermoelectric Power of Gd<sub>4</sub>(Co-A)<sub>3</sub> Compounds (A = Cu, Pt)**  
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**Keywords:** thermoelectric power; gadolinium-cobalt compounds; electron band structure.

**Abstract:** We report on a comparative study of thermoelectric power measurements ( $S(T)$ ) in ferrimagnetic Gd<sub>4</sub>(Co<sub>1-x</sub>A<sub>x</sub>)<sub>3</sub> compounds with A = Cu, Pt, in the temperature range 8 K – 300 K. Whereas in Gd<sub>4</sub>Co<sub>3</sub>  $S(T)$  is always negative, for  $x > 0$  the substitution of Co for Cu/Pt gives rise to the appearance of a low temperature positive maximum in  $S(T)$  at around 30 K. Based on our previous study of Gd<sub>4</sub>(Co<sub>1-x</sub>Cu<sub>x</sub>)<sub>3</sub> compounds, we argue that this maximum in  $S(T)$  originates from electron-magnon scattering and is sensitive to electron band structure changes resulting from the substitution of Co for Cu/Pt and the accompanying reduction in the ratio between the electron-magnon and the electron-phonon scattering strengths. The decreasing role of Co 3d electrons with the progressive substitution of Co for Cu/Pt, evidenced by a strong reduction in the spin disorder resistivity and the Co magnetic moment, is seen to be crucial for the existence of such low temperature maximum in  $S(T)$  for  $x > 0$ . It is seen that the substitution of Co for Pt leads to higher values of the amplitude and temperature of the positive maximum in  $S(T)$  than the substitution of Co for Cu.

**Introduction:** In Gd<sub>4</sub>Co compounds, as the Co/Gd concentration ratio increases, the inherent character of the magnetism is reinforced, whereas compounds with a low Co/Gd concentration ratio are expected to exhibit a magnetic behavior much closer to that of localized magnetism typical of rare earths. Having a low Co/Gd concentration ratio and crystallizing in the hexagonal R<sub>2</sub>Co<sub>2</sub> type structure [1], Gd<sub>4</sub>Co<sub>3</sub> is a special system. It orders ferromagnetically below  $T_c = 220$  K [2–5] with the Co magnetic moments antiparallelly coupled to those of Gd and exhibits a large magnetoelastic effect with negligible hysteresis loss [6]. In Gd<sub>4</sub>(Co<sub>1-x</sub>A<sub>x</sub>)<sub>3</sub> compounds with  $x = 0.05, 0.1, 0.2$ , and  $0.3$ , the spin disorder resistivity shows a pronounced decrease with increasing  $x$  that can be attributed to the observed reduction of the magnetic moment of Co atoms [7]. This reveals the important role played by 3d-band electrons in both magnetic state and in the strong  $\omega$ -electron scattering. Magnon-induced electron scattering is also apparent in all compounds through well-defined maxima in the temperature derivative of the electrical resistivity  $d\rho/dT$  at temperatures ranging from 37 K to 48 K, where the magnetic contribution to  $d\rho/dT$  reveals the phonon contribution [8]. The combined analysis of the spin disorder resistivity and the electron-specific heat coefficient pointed to important changes in band structure with the substitution of Co for Cu [7]. The effect on the thermoelectric power of such band structure changes were also investigated [9]. It has been found that, whereas in Gd<sub>4</sub>Co<sub>3</sub>  $S(T)$  is always negative, for  $x > 0$  the substitution of Co for Cu gives rise to the appearance of a low temperature positive maximum in  $S(T)$  at around 30 K. It was argued that this maximum in  $S(T)$  originates from electron-magnon scattering and is sensitive to electron band structure changes resulting from the substitution of Co for Cu and the accompanying reduction in the ratio between the electron-magnon and the electron-phonon

We report on a comparative study of thermoelectric power measurements ( $S(T)$ ) in ferrimagnetic Gd<sub>4</sub>(Co<sub>1-x</sub>A<sub>x</sub>)<sub>3</sub> compounds with A = Cu, Pt, in the temperature range 8 K – 300 K. Whereas in Gd<sub>4</sub>Co<sub>3</sub>  $S(T)$  is always negative, for  $x > 0$  the substitution of Co for Cu/Pt gives rise to the appearance of a low temperature positive maximum in  $S(T)$  at around 30 K. Based on our previous study of Gd<sub>4</sub>(Co<sub>1-x</sub>Cu<sub>x</sub>)<sub>3</sub> compounds, we argue that this maximum in  $S(T)$  originates from electron-magnon scattering and is sensitive to electron band structure changes resulting from the substitution of Co for Cu/Pt and the accompanying reduction in the ratio between the electron-magnon and the electron-phonon scattering strengths. The decreasing role of Co 3d electrons with the progressive substitution of Co for Cu/Pt, evidenced by a strong reduction in the spin disorder resistivity and the Co magnetic moment, is seen to be crucial for the existence of such low temperature maximum in  $S(T)$  for  $x > 0$ . It is seen that the substitution of Co for Pt leads to higher values of the amplitude and temperature of the positive maximum in  $S(T)$  than the substitution of Co for Cu.

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