

## EFFECT OF PRESSURE ON THE MAGNETIC TRANSITION TEMPERATURES IN $(\text{Cr}_{1-x}\text{Rh}_x)_3\text{Te}_4$

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**Abstract.** - The pressure derivatives of the Curie temperature and the spin canted one in  $x = 0.17$  are  $-(4.1 \pm 0.3)$  and  $+(2.3 \pm 0.4)$  in units of K/kbar, respectively. Those of the transition temperature between the canted ferromagnetic and paramagnetic phases in  $x = 0.17$  (high pressure) and 0.33, respectively, are  $-(4.1 \pm 0.6)$  and  $-(3.1 \pm 0.2)$  in units of K/kbar.

The ferromagnetic compound  $\text{Cr}_3\text{Te}_4$  is characterized by a canted ferromagnetic (CF)-ferromagnetic (F) transition at a temperature ( $T_t$ ) [1] and a large negative pressure derivative of the Curie temperature ( $T_c$ ) ( $-5.9 \pm 0.1$  K/kbar) [2]. In the magnetically diluted system  $(\text{Cr}_{1-x}\text{Rh}_x)_3\text{Te}_4$ ,  $T_t$  increases and  $T_c$  decreases as  $x$  increases [3]. Both  $T_t$  and  $T_c$  combine at a point ( $x = 0.21 \pm 0.03$ ,  $T = (165 \pm 5)$  K). When  $x$  further increases, only a CF-paramagnetic transition is observed at a temperature ( $T_{CF}$ ). These behaviours are explained with the  $x$ -dependence of the virtual exchange integrals. In this paper,  $T_c$  and  $T_t$  in  $(\text{Cr}_{0.83}\text{Rh}_{0.17})_3\text{Te}_4$  and  $T_{CF}$  in  $(\text{Cr}_{0.67}\text{Rh}_{0.33})_3\text{Te}_4$  are investigated under pressure as the typical examples of the magnetic transitions in  $(\text{Cr}_{1-x}\text{Rh}_x)_3\text{Te}_4$ .

The powder samples were prepared with the same procedure [4] reported previously. The measurements of the temperature ( $T$ ) dependences of magnetic permeability ( $\mu$ ) at hydrostatic pressure ( $P$ ) were carried out by using a piston-cylinder type apparatus on heating runs.

Figure 1 shows the temperature dependence of  $\mu$  for  $(\text{Cr}_{0.83}\text{Rh}_{0.17})_3\text{Te}_4$  at various pressures. At normal pressure,  $\mu$  exhibits a sharp peak at  $T = 170$  K and a discontinuity in  $d\mu/dT$  at  $T = 110$  K. By comparing this curve with the magnetization ( $\sigma$ ) vs.  $T$  curve of  $x = 0.17$  [3],  $T_c$  is assigned as the intersection of the high temperature-side of the peak and the higher temperature range, and  $T_t$ , the temperature of the discontinuity in  $d\mu/dT$  as shown in figure 1. As  $P$  increases,  $T_c$  decreases and  $T_t$  increases. Above  $P = 10.9$  kbar, the discontinuity in  $d\mu/dT$  at  $T_t$  gets blurred and  $\mu$  exhibits only a sharp peak whose magnitude decreases with increasing  $P$ . As described below (Fig. 3), this type of peak in  $\mu$  is also observed in  $x = 0.33$  just below  $T_{CF}$  determined on the  $\sigma$  vs.  $T$  curve [3] at normal pressure. The peak is regarded as the presence of the CF-paramagnetic transition. Then,  $T_{CF}$  is determined with the same manner to that for  $T_c$ . As seen in figure 2,  $T_c$  and  $T_t$  of  $x = 0.17$  decreases and increases in

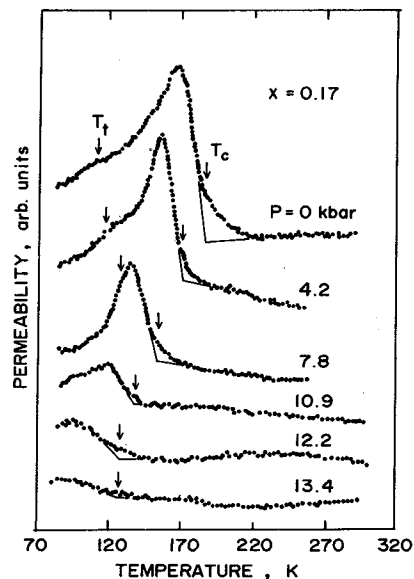


Fig. 1. - Temperature dependence of permeability for  $(\text{Cr}_{0.83}\text{Rh}_{0.17})_3\text{Te}_4$  at various pressures.

the pressure derivatives  $dT_c/dP = -(4.1 \pm 0.3)$  and  $dT_t/dP = +(2.3 \pm 0.4)$  in units of K/kbar, respectively. Above a triple point ( $P = (8.6 \pm 0.3)$  kbar,  $T = (143 \pm 3)$  K),  $T_c$  and  $T_t$  combine to make a transition line with  $T_{CF}$  whose pressure derivative is  $dT_{CF}/dP = -(4.1 \pm 0.6)$  K/kbar. Figure 3 shows the temperature dependence of  $\mu$  for  $(\text{Cr}_{0.67}\text{Rh}_{0.33})_3\text{Te}_4$  at various pressures. At normal pressure,  $\mu$  exhibits only a sharp peak whose magnitude decreases with increasing  $P$ . This thermal variation of  $\mu$  has the same feature as the case of  $x = 0.17$  at the higher pressures. As shown in figure 2,  $T_{CF}$  decreases with increasing  $P$ , from which the pressure derivative is determined to be  $dT_{CF}/dP = -(3.1 \pm 0.2)$  K/kbar.

It has been pointed out that an enhancement of the contribution of negative exchange integrals in the effec-

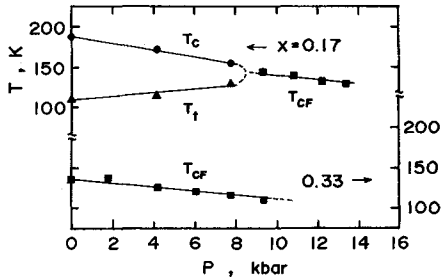


Fig. 2. - Pressure dependences of the magnetic transition temperatures  $T_c$ ,  $T_t$  and  $T_{CF}$  for  $(Cr_{1-x}Rh_x)_3Te_4$  with  $x = 0.17$  and  $0.33$ .

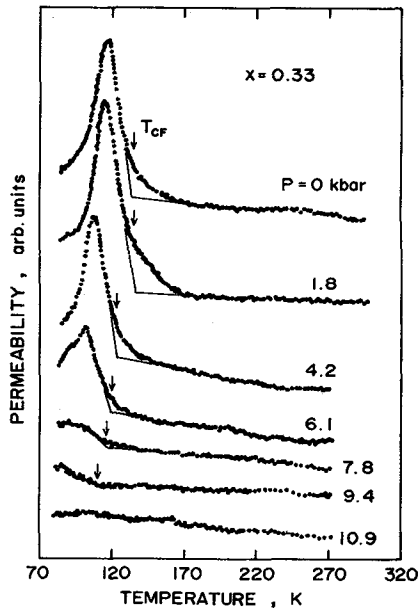


Fig. 3. - Temperature dependence of permeability for  $(Cr_{0.67}Rh_{0.33})_3Te_4$  at various pressures.

tive magnetic interactions suppresses  $T_c$  and  $T_{CF}$  but rises  $T_t$  as  $x$  increases in  $(Cr_{1-x}Rh_x)_3Te_4$  [3]. The  $P - T$  diagram observed in  $(Cr_{0.83}Rh_{0.17})_3Te_4$  fairly coincides with the  $x - T$  one [3] when  $P$  is linearly scaled to  $x$ . This feature is also supported with the pressure dependence of  $T_{CF}$  in  $(Cr_{0.67}Rh_{0.33})_3Te_4$ . It is plausible that the reduction in interatomic distances or the variation in the axial ratio introduced by pressure takes sides with the antiferromagnetic contributions which compete to the predominant ferromagnetic effective exchange integrals in this system. As a supplementary notice, there are some quantitative differences in  $dT_c/dP$  between  $x = 0$  and  $0.17$  and those in  $dT_{CF}/dP$  between  $x = 0.17$  (high pressure) and  $0.33$ . In order to study these features, a systematic investigation, together with the exchange strictions, over the more wide range of  $x$  are now in progress.

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