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**Effect of Hydrostatic Pressure on the Curie Temperatures of Ferroelectric  $\text{CH}_3\text{NH}_3\text{Al}(\text{SO}_4)_2 \cdot 12\text{H}_2\text{O}$  (MASD) and  $\text{NaNH}_4\text{SeO}_4 \cdot 2\text{H}_2\text{O}$**

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The effect of hydrostatic pressure on a ferroelectric phase transition has been known as a good indicator for the type of a given ferroelectric material; the pressure coefficient of the Curie temperature is negative for both ferroelectrics of displacive type and of hydrogen-bond type, while it is positive for those of order-disorder type.<sup>1)</sup> We have measured the effect of hydrostatic pressure on the ferroelectric Curie temperatures of two ferroelectrics containing hydrogens,  $\text{CH}_3\text{NH}_3\text{Al}(\text{SO}_4)_2 \cdot 12\text{H}_2\text{O}$  (MASD) (The Curie temperature at 1 atm  $T_c^0 = -96^\circ\text{C}^{2)}$  and  $\text{NaNH}_4\text{SeO}_4 \cdot 2\text{H}_2\text{O}$  ( $T_c^0 = -94^\circ\text{C}^{3)}$ ). The experimental procedures were described elsewhere,<sup>4)</sup> and the Curie temperatures were determined from measurements of the dielectric constants at various hydrostatic pressures.

Figure 1 shows the pressure dependence of the Curie temperature of MASD. The Curie temperature  $T_c$  linearly increases with increasing hydrostatic pressure  $p$  up to about 7 kbar with a coefficient of  $dT_c/dp = 2.5 \pm 0.1 \text{ deg kbar}^{-1}$ . The result for  $\text{NaNH}_4\text{SeO}_4 \cdot 2\text{H}_2\text{O}$  is indicated in Fig. 2. In contrast to the case of MASD, the Curie temperature of  $\text{NaNH}_4\text{SeO}_4 \cdot 2\text{H}_2\text{O}$  decreases with increasing pressure, having

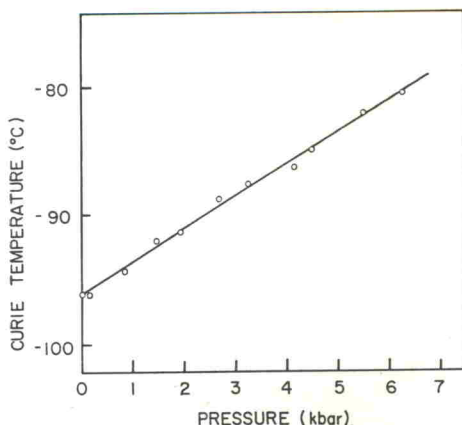


Fig. 1. Hydrostatic pressure dependence of the Curie temperature of  $\text{CH}_3\text{NH}_3\text{Al}(\text{SO}_4)_2 \cdot 12\text{H}_2\text{O}$  (MASD).

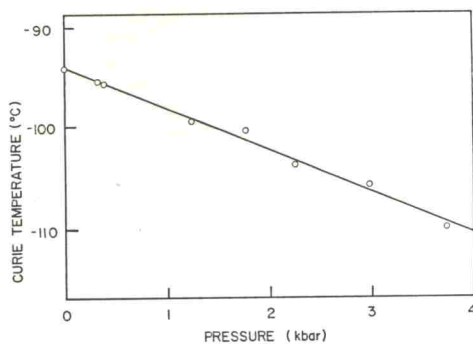


Fig. 2. Hydrostatic pressure dependence of the Curie temperature of  $\text{NaNH}_4\text{SeO}_4 \cdot 2\text{H}_2\text{O}$ .

a rate of  $dT_c/dp = -(4.1 \pm 0.2) \text{ deg kbar}^{-1}$ .

The present results suggest that a proton collective motion in the hydrogen bonds may be less important for the ferroelectric process in MASD than for that in  $\text{NaNH}_4\text{SeO}_4 \cdot 2\text{H}_2\text{O}$ . In fact, deuteration of hydrogens in MASD does not alter the Curie temperature,<sup>5)</sup> being consistent with the above suggestion.

#### References

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