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Dielectric Study of the Pressure Effect on the Cubic-Tetragonal Phase Transition in $KMnF_3$

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At about 186 K, $KMnF_3$ undergoes a structural phase transition; the room temperature structure of cubic perovskite type (space group: O_h^1) transforms to a tetragonal structure (space group: D_{4h}^{18}).[1] The phase transition is caused by an instability of a soft zone boundary phonon of Γ_{25} mode at R-point of the reciprocal space.[2] The mechanism of phase transition is therefore similar to that of 110 K transition in $SrTiO_3$.[3] Neutron diffraction study by Shirane *et al.*[4] showed that the 186 K transition in $KMnF_3$ is of the first order though it is very close to the second order one. Recently, one of the present authors (KG) found that there was a slight discontinuity of about 0.1 % in the low frequency dielectric constant accompanying the 186 K transition in $KMnF_3$.[5] Then, the effect of hydrostatic pressure on the 186 K transition can be rather easily studied by dielectric constant measurements.

A (100) plate of which dimension was 0.25 $cm^2 \times$ 0.35 mm was cut out of a single crystal block. After attached silver paste as the electrodes, the specimen was set in a Cu-Be high pressure bomb which had seven electrical terminal plugs. The pressure transmitting fluid used was 50-50 mixture of iso- and n-pentane. At a constant pressure, the dielectric constant was measured with a three terminal capacitance bridge as a function of temperature with an applied field of 25 V_{rms} at 1 kHz. Temperature was controlled with a liquid nitrogen bath, and measured with a copper-constantan thermocouple set closely around the specimen. Pressure was measured with a manganine gauge.

Figure 1 shows the temperature dependence of the dielectric constant at different pressures. At the cubic-tetragonal phase transition point T_c, a discontinuous change and a slight thermal hysteresis in each dielectric constant vs temperature curve are clearly seen. The transition temperature increases with

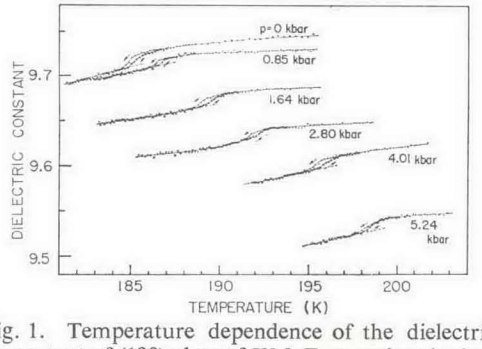

Fig. 1. Temperature dependence of the dielectric constant of (100) plate of $KMnF_3$ at various hydrostatic pressures. Frequency: 1 kHz.
●: on cooling, ×: on heating.

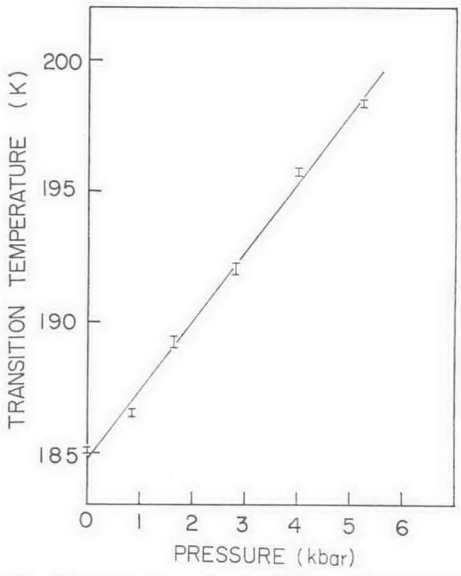

Fig. 2. Pressure dependence of the cubic-tetragonal phase transition temperature of $KMnF_3$ obtained from the dielectric constant measurements. The vertical bars indicate the thermal hysteresis during cooling and heating runs.

increasing hydrostatic pressure. Figure 2 shows the pressure dependence of the transition temperature. In the figure, the vertical bars represent the thermal hysteresis. Up to about 6 kbar, the T_c vs p relation is linear with a slope of $dT_c/dp = 2.63 \pm 0.09$ K $kbar^{-1}$. The value is slightly smaller than that of 3.5K $kbar^{-1}$ obtained by Okai and Yoshimoto[6] from a sound velocity measurement, but it is in good agreement with a thermodynamical expectation of 2.9 K $kbar^{-1}$.[7]

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