under $1/\epsilon_r=0$ versus pressure is obtained by replotting from Fig. 8(a) as shown in Fig. 7(b), then it is found that the characteristic temperature(T_0) decreases linearly with increasing pressure. Accordingly, T_0 is expressed as follows;

$$T_0 = \alpha_2 - \beta_2 p \qquad (30)$$

where α_2=104°C & β_2=4.92°C/kbar from Fig. 7(b). By putting eq. (30) into T_0 of eq. (23) & eq. (24), the following formulas are obtained;

$$\frac{1}{\epsilon_r} = -4C_0(T-\alpha_2+\beta_2 p) + \frac{\xi^2}{\zeta}\left\{1+\sqrt{1-\frac{4\zeta C_0}{\xi^2}(T-\alpha_2+\beta_2 p)}\right\} \qquad (31)$$

$$P_s^2 = -\frac{\xi}{2\zeta}\left\{1+\sqrt{1-\frac{4\zeta C_0}{\xi^2}(T-\alpha_2+\beta_2 p)}\right\} \qquad (32)$$

The temperature dependence of $1/\epsilon_r$ at pressure parameter p=7.7, 10.3 & 12.4 kbar is expressed as a solid line in Fig. 8(a) by putting the previous values of ξ & ζ at T=23°C and above values of C_0, α_2 & β_2 into eq. (31). The temperature dependence of P_s is also expressed similarly as a solid line in Fig. 8(b) from eq. (32). Here, since the abscissa in Fig. 8(b) is the reduced temperature $(T - T_c)$, the characteristic curves with each pressure parameter overlap as a one line. Comparable large difference between the measured value and the calculated one is observed in Fig. 8(a). This cause is considered to be based on the temperature & pressure dependence of the coefficients C_0, ξ & ζ. Let's consider this effect subsequently. The pressure dependence of the transition temperature(T_c) must be same as that of the characteristic temperature(T_0) from eq. (25). However, the paper reports that there is some difference between dT_c/dp=–5.5°C/kbar and dT_0/dp=–4.8°C/kbar in experimental value[6]. Furthermore, though all curves which are the reduced temperature $(T-T_c)$ versus spontaneous polarization with pressure parameters must overlap as a one line, the value of P_s decreases gradually with increasing pressure parameter like a dotted line (or the measured value) in Fig. 8(b). These facts suggest that the coefficients C_0, ξ & ζ depend on pressure a little. However, the temperature dependence of the coefficient ζ of higher order of P_s in the expansion formula of the free energy is considered to be extremely small, and therefore, the pressure dependence of the coefficient ζ is also assumed to be extremely small. The slope C_0 is known to be independent of pressure from experimental results. Consequently, in this case, the pressure dependence of the coefficient ξ should be considered. Here, let's add the little quantity $\triangle\xi$ to the value of ξ to compensate ξ. In order to obtain the value of $\triangle\xi$, the following method is performed, that is, from eq. (21),

$$dP_s/dp = -g\zeta/2P_s\sqrt{\xi^2-4\zeta(u+gp)} \qquad (33)$$

still more, by substituting $\xi + \triangle\xi$ for ξ in eq. (33)

$$dP_s/dp = -g\zeta/2P_s\sqrt{(\xi+\triangle\xi)^2-4\zeta(u+gp)} \qquad (34)$$

First, let's put p=7.7 kbar and the previous values of u, g, ξ & ζ at T=23°C into eq. (33) & eq. (34), and put simultaneously the values of dP_s/dp obtained from the slope of the experimental curve (or the dotted line) & the calculated one (or the solid line) at p=7.7 kbar & T=23°C in Fig. 6(b), that is, $dP_s/dp=3.80\times10^{-3}$ $C/m^2\cdot$kbar (or the measured value) & $dP_s/dp=3.13\times10^{-3}$ $C/m^2\cdot$kbar (or the calculated value) into eq. (34) & eq. (33) respectively. Next, let's take the ratio eq. (34) to eq. (33) in order to find the value of $\triangle\xi$; $\triangle\xi=0.373\times10^9$ $m^5/F\cdot C^2$. The compensated curve of $1/\epsilon_r$ versus T obtained by calculation is shown as a dot-dash-line in Fig. 8(a) by putting

$\xi + \triangle\xi = -0.96 \times 10^9\, m^5/F{\cdot}C^2$ into ξ of eq. (24). In this case, the compensated quantity $\triangle\xi$ is 28% of the previous value of ξ, and the calculated value of $1/\epsilon_r$ approaches to the measured value by about 36% in comparison with the previous case.

(ii) The electric field dependence of the permittivity; The temperature dependence of the reciprocal relative permittivity of the ceramic ($PbTiO_3$25% + $PbSnO_3$75%) at atmospheric pressure obtained by the authors is shown as a dotted line in Fig. 9(a). The slope C_0 of $1/\epsilon_r$ to T in

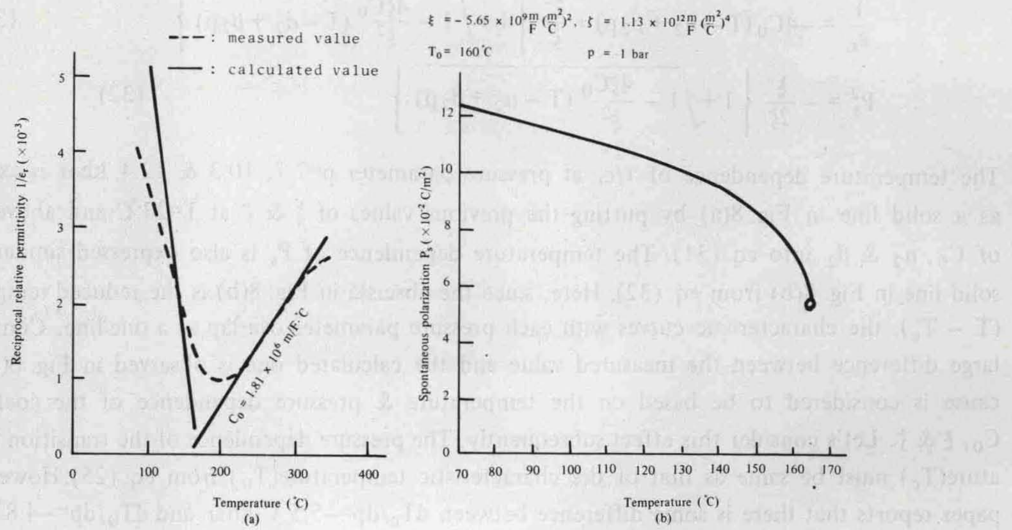

Fig. 9. The temperature dependence of (a) the reciprocal relative permittivity & (b) the spontaneous polarization of Pb(Ti(25%)+Sn(75%)) O_3 at 1 bar.

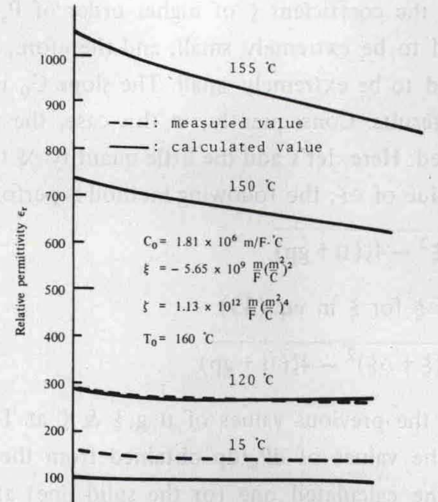

Fig. 10. Effect of external electric field on the relative permittivity of Pb(Ti(25%)+Sn(75%))O_3 under various temperatures.