

Fig. 6. The pressure dependence of (a) the reciprocal relative permittivity & (b) the spontaneous polarization of single crystal BaTiO_3 with temperature parameter.

A little difference is seen between the calculated value and the measured one, and this reason is considered to be as follows;

(1) Though the value of $1/\epsilon_r$ must be minimized value at the transition pressure and the spontaneous polarization P_s must be zero at this pressure theoretically, the pressure where $1/\epsilon_r$ is minimized value is 20 kbar and the pressure where P_s is zero is 22 kbar as shown as a dotted line in Fig. 6(a) & (b), then the difference between these values is 2 kbar.

(2) The coefficients u , g , ξ and ζ are assumed to be independent of pressure analytically here. However, practically, these coefficients will depend on pressure more or less.

Anyway, the experimental error could not be escaped even if modern equipments were used in such a measurement.

Let's examine the temperature dependence of the coefficients u & g . The coefficient g is considered to be independent of temperature, because the slope g of $1/\epsilon_r$ to p in paraelectric phase is constant under various temperatures. The temperature dependence of the coefficient u will be

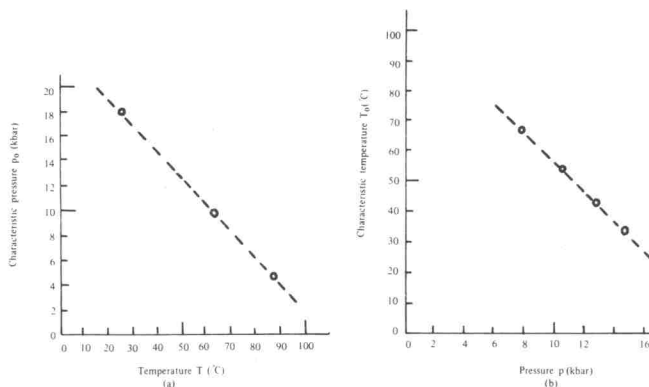


Fig. 7. (a) The temperature dependence of the characteristic pressure P_0 & (b) the pressure dependence of the characteristic temperature T_0 of single crystal BaTiO_3 .

found by investigating the temperature dependence of the characteristic pressure (p_0) by using eq.(6). The characteristic pressure (p_0) versus temperature is obtained by replotting from Fig.6(a), and Fig.7(a) shows these relations. From Fig.7(a), it is noticed that the characteristic pressure decreases linearly with increasing temperature. Therefore, by reminding the relation $u = -gp_0$, the coefficient u is expressed as follows;

$$u = -g(a_1 - \beta_1 T) \quad (27)$$

where $a_1 = 22.8$ kbar & $\beta_1 = 0.217$ kbar/°C from Fig. 7(a). By putting eq.(27) into u of eq. (21) & eq. (22),

$$\frac{1}{\epsilon_r} = 4 \left\{ g(a_1 - \beta_1 T) - gp \right\} + \frac{\xi^2}{\zeta} \left[1 + \sqrt{1 + \frac{4\zeta}{\xi^2} \{g(a_1 - \beta_1 T) - gp\}} \right] \quad (28)$$

and

$$P_s^2 = -\frac{\xi}{2\zeta} \left[1 + \sqrt{1 + \frac{4\zeta}{\xi^2} \{g(a_1 - \beta_1 T) - gp\}} \right] \quad (29)$$

are obtained, and then the effect of temperature is added to eq. (22) & eq. (21) respectively. The curves of $1/\epsilon_r$ versus p & P_s versus p at $T = 60^\circ\text{C}$ & 85°C calculated from eq. (28) & eq. (29) are shown as a solid line in Fig. 6(a) & (b) respectively.

The temperature versus reciprocal relative permittivity with pressure parameter and the temperature versus spontaneous polarization with pressure parameter are shown as a dotted line in Fig. 8(a)

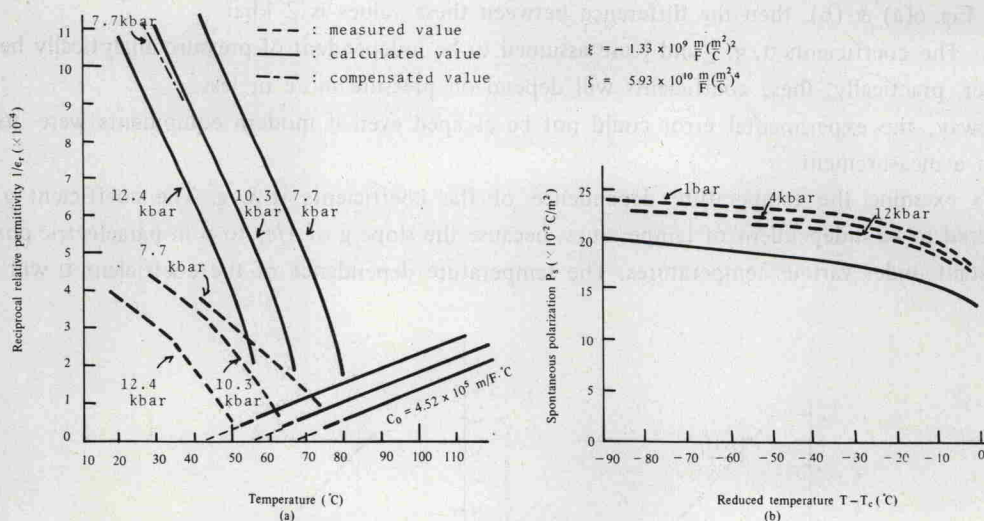


Fig. 8. The temperature dependence of (a) the reciprocal relative permittivity & (b) the spontaneous polarization of single crystal BaTiO_3 with pressure parameter.

& (b) respectively. In order to consider the pressure dependence of the spontaneous polarization shown in eq. (23) and the relative permittivity shown in eq. (24), first, the pressure dependence of C_0 & T_0 must be examined. The slope C_0 of $1/\epsilon_r$ to T in paraelectric phase above the transition temperature (T_c) in Fig. 8(a) is constant under various pressure parameters, that is, $C_0 = 4.52 \times 10^5$ m/F·°C and then is independent of pressure. On the other hand, the characteristic temperature (T_0)