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[14]We note that the presence of zero-point vibrations in the crystal will contribute slightly to produce σ values different from $\frac{1}{4}$. The 6-12(1N) model of T. H. K. Barron and M. L. Klein [Proc. Phys. Soc. (London) 85, 533 (1965)] includes such zero-point effects and predicts $\sigma = 0.257$. It is this model which makes the best published prediction of $\Theta_0{}^c$, the equivalent Debye temperature in the limit $T \rightarrow 0$.

CHANGE IN THE DIELECTRIC CONSTANT OF SbSI CAUSED BY ILLUMINATION

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We have measured the change in the dielectric constant of SbSI caused by illumination. The change is positive below the Curie temperature and negative above. The result is discussed in connection with the strain caused by illumination reported previously.

In this Letter, we report a change in the dielectric constant ϵ' of SbSI along the c axis caused by illumination. The change is discussed in connection with the strain $\Delta L^i/L$ along the c axis caused by illumination in the presence of a dc electric field along the c axis.[1]

The area of the (001) faces of the specimens used was about 10^{-2} mm^2, and the Curie temperature (T_c) was about 19.5°C. Evaporated gold on both sides [(001)] was used as electrodes. The measurements were made at 1 kc/sec using an inductive arm bridge, which is similar to that described by Cole and Gross.[2] The strength of the applied ac electric field in a specimen was less than 0.1 V/cm. The dc electric field was applied from a stabilized voltage supply to a specimen through a high resistance. The illumination was provided by a normal 150-W incandescent lamp through an interference filter.

Typical experiment results are shown in Fig. 1. Curve A shows the temperature dependence of ϵ' in the dark without the dc electric field. Curves B and C show the temperature dependence of ϵ' in the dark and that of ϵ' affected by the illumination, respectively, in the presence of a dc electric field of 1 kV/cm along the c axis. ϵ' is increased by the illumination below T_c and decreased above. Furthermore, it should be noted that ϵ' decreases when a dc electric field of 1 kV/cm is applied.

If the observed change in ϵ' caused by the illumination were attributed to the change of the applied electric field E which might come

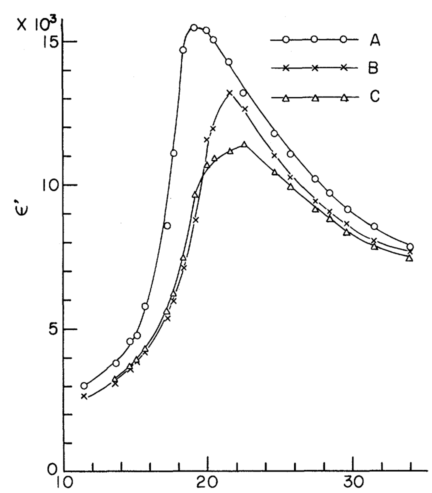

FIG. 1. A: temperature dependence of ϵ' in the dark. B: ϵ' in the dark in the presence of 1.0 kV/cm. C: ϵ' affected by an illumination of 550-mμ wavelength in the presence of 1.0 kV/cm.

from an electromotive force generated by the illumination, E would have been decreased by the illumination below T_C and increased above as seen from Fig. 1. If the origin of $\Delta L^i/L$ were also attributed to the change of E mentioned above, $\Delta L^i/L$ would have been negative below T_C and positive above. This inference contradicts the experimental result of Ref. 1. At the present stage, therefore, it seems natural to think that ϵ' itself is changed instead of considering the change in E.

When a specimen is illuminated in the presence of a dc electric field, both $\Delta L^i/L$ and the dielectric change $\Delta\epsilon'$ show a saturation at quite low intensity of light; yet a conduction current still increases with the increase of the intensity. Furthermore, the relaxation time of $\Delta L^i/L$ is much longer than that of the conduction current. From these results, it can be concluded that the conduction current does not play an important role in the origin of $\Delta L^i/L$ and $\Delta\epsilon'$.

Existence of a piezoelectric effect detected up to a temperature several degrees above T_C is reported by Hamano et al.[3] One can observe a small hysteresis loop up to a temperature of 30°C in some specimens. This can be attributed to imperfections in the specimen. It is not hard to think that there are many imperfections which are distributed inhomogeneously in a specimen. The imperfections would lead to a distribution of T_C in a specimen. The distribution makes it possible to reduce the spontaneous polarization near T_C in the ferroelectric phase and to observe ferroelectric properties such as the piezoelectric effect and the hysteresis loop above T_C.

If it is allowed to assume that the illumination makes it possible to narrow the width of the distribution of T_C, though a detailed mechanism of narrowing has not been clarified yet, one can expect an increment and a reduction of the polarization P, respectively, below T_C and above, when a specimen is illuminated. The change of P is reflected in a positive $\Delta\epsilon'$ below T_C and a negative one above. Since the change in ϵ' can be associated with the change in the piezoelectric modulus d, positive $\Delta L^i/L$ below T_C and negative $\Delta L^i/L$ above are expected. The assumption seems to be favorable for explaining that the temperature range at which both $\Delta L^i/L$ and $\Delta\epsilon'$ are observed is roughly limited to within $T_C \pm 10$°C.

If the change in d is taken into consideration through $\Delta\epsilon'$ only, $\Delta L^i/L$ of the order of 10^{-6} is estimated in the presence of an electric field of 1 kV/cm near T_C in the ferroelectric phase, using the data on the dielectric constant in Fig. 1 and on both the elastic-compliance coefficient and the electromechanical coupling factor.[3] The measured values range from 10^{-4} to 10^{-5}.

Recently, a similar change in ϵ' caused by an illumination has been observed, using microwave frequency, by Shinohara and Ogushi.[4]

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