ıe anomalously large photovoltage effect in ıtimony orthoniobate

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Observations and investigations were made of the effect of anomalously large photovoltages (the APV effect) in single crystals of the ferroelectric antimony orthoniobate. The photo-emf in $SbNbO_4$ in the [001] direction exceeds the width of the forbidden band ($E_g \approx 3$ eV) by one order of magnitude.

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[t is known that the photo-emf in semiconductors, regardless of its nature, ınot exceed the width of the forbidden band, i.e., several volts. The only ceptions are semiconducting textures, in which an anomalously large photo-ltage effect (APV effect) is observed; this effect is due to the superposition the elementary photo-emf that develop across the *p–n* junctions of the ture.[1]

We have observed the APV effect in single crystals of the ferroelectric

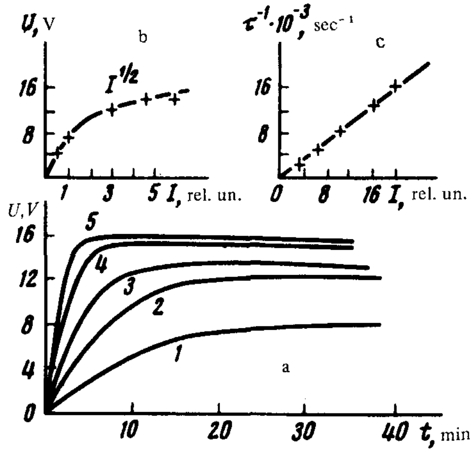

FIG. APV effect in antimony orthoniobate: a) Kinetics of the APV effec at various light intensities I. Curves 1—5 correspond to light intensities $I = 0.02$, 0.06, 0.12, 0.2, and 0.4 W/cm^2. b) Dependence of $v(\tau)$ on I; c) Dependence of τ on I.

antimony orthniobate. The $SbNbO_4$ crystals were illuminated with an argon las er (488 nm) in the spontaneous-polarization direction [001]. The photo-emf v was measured in the same direction. The photo-emf in the perpendicular dire tion was negligibly small. The measurement results are shown in Figs. a, b, and c. When the light is turned on, the photo-emf v increases within a time τ to a stationary value $v(\tau)$ that depends on the light intensity I (Fig. a). After t light is turned off, v remains constant. The pyroeffect is negligible and has n influence on the measurement of v. Figure b shows a plot of $v(\tau)$ against I; at small I this plot is close to $I^{1/2}$, and it is seen from Fig. c that the time τ is inversely proportional to I.

These results show that the photo-emf in $SbNbO_4$ in the [001] direction exceeds by one order of magnitude the width of the forbidden band ($E_g \approx 3$ eV), and seems to be limited by the crystal thickness L in this direction ($L \approx 0.02$ cm). It can be assumed that the APV effect in $SbNbO_4$ belongs to the class of photo-ferroelectric phenomena[2,3] that have the same mechanism as the so-called optical distortion, which constitutes a photo-induced change of the birefringence Δn.[4,5] In this case optical charge exchange of the centers, due to the nonequilibrium conductivity, changes the spontaneous induction by an amount ΔD, leads to formation of a depolarization field $E = \Delta D/\epsilon$ and of a photo-emf $v = (\Delta D/\epsilon)L$. For $\epsilon \approx 240$,[6] $L \approx 0.02$ cm, and $\Delta D \approx 10^{-6}$ C/cm^2 (this value corresponds to saturation of the optical-distortion effect in the lithium niobate[4,5]) we have $v = 75$ V, which is close to the experimentally measured values of the photo-emf. Unfortunately, the antimony orthoniobate crystals grown by the hydrothermal method[6] were in the shape of thin plates with advanced face (001), so that the effect of the optical distortion Δn in the [100] direction could not be observed and it was impossible to estimate ΔD independently. However, the similar character of the functions $\Delta n = \Delta n(I)$ and $v = v(I)$, the $\tau = \tau(I)$ dependence, and our estimates, all confirm the assumption that APV effect in $SbNbO_4$ and the optical distortion are governed by a common mechanism.

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