RELATION BETWEEN THE COERCIVE AND THE THRESHOLD EFFECTIVE ELECTRIC FIELD GENERATING THE ELECTRIC DISCHARGES AT THE SURFACE OF TGS SINGLE CRYSTALS

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The dependence of both the coercive field and the threshold effective electric field generating the electric discharges at the surface of TGS single crystals on the sample thickness was measured. The correlation between the ccercive field and the threshold effective electric field has been established.

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1. *Introduction*

Recently, the investigation of apparent exoelectron emission and photon emission accompanying the electric discharges in a gas atmosphere surrounding the ferroelectric sample was discussed [1–4]. These discharges are induced by local electric fields related to the domain structure reconstruction due to the repolarization of the ferroelectric samples by an alternating external voltage. The measurable apparent exoelectron emission as well as the photon emission intensity is observed at a definite value of the threshold polarization potential U_p, as was stated by Sujak and Kusz [1, 2].

The study performed by Biedrzycki [3, 4] has shown, that the threshold polarization potential U_p stimulating the apparent exoelectron emission and photon emission intensity depends on the thickness of TGS samples. The threshold effective electric field E_p estimated on the basis of these investigations depends on the sample thickness d in the following way:

$$E_p = M + \frac{N}{d}, \tag{1}$$

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where M, N are constants depending on the kind of studied material and d is the sample thickness.

The nonlinear dependence of the ferroelectric polarization on the electric field causes that the dielectric hysteresis loop is observed in the alternating electric field. When observing the hysteresis loop form, we can see that the intensive reconstruction of the ferroelectric domain structure appears in the electric field of the value close to the value of the coercive field. In the case of $BaTiO_3$ single crystals, the dependence of the coercive field E_c on the sample thickness d is described by the following equation (Merz [5]):

$$E_c = A + \frac{B}{d}, \tag{2}$$

where A, B are constants and d is the sample thickness.

In this paper we compare the coercive field E_c with the threshold effective electric field E_p, stimulating the electric discharges at the surface of TGS single crystals.

2. *Results and discussion*

The dependence of the coercive field E_c, taken from the observation of the hysteresis loop in the Diamant, Drenck and Pepinsky arrangement [6] as a function of the reciprocal thickness of the monocrystalline TGS samples is shown in Fig. 1 (curve *1*). Equation (2) describes this dependence for TGS single crystals. The values of constants A and B have

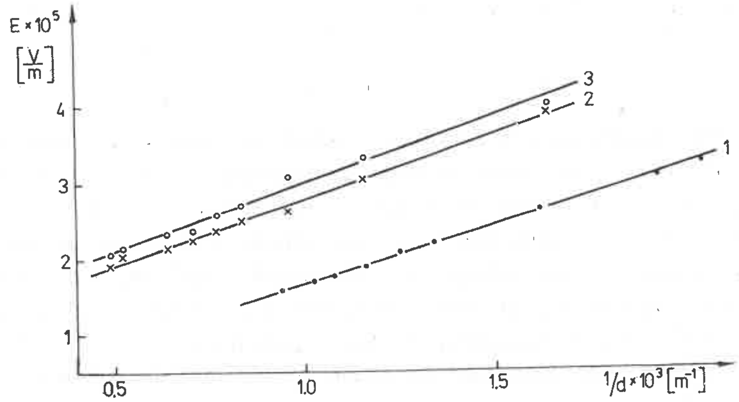

Fig. 1. The dependence of the coercive field E_c (curve *1*) and the threshold effective electric field E_p (curve *2* and *3*) versus $1/d$ for the TGS single crystals

been obtained by the method of least squares and they are $A = 0.21 \cdot 10^5$ V/m, $B = 163$ V.

The dependence of the threshold effective electric field E_p of the reciprocal thickness obtained on the basis of the measurable apparent exoelectron emission (curve *2*) and photon emission (curve *3*) intensity are shown in Fig. 1 [3, 4]. Equation (1) describes the dependence of the field E_p on sample thickness. The value of constants M and N are:

$M_1 = 1.09 \cdot 10^5$ V/m, $N_1 = 167$ V (curve *2*) and $M_2 = 1.24 \cdot 10^5$ V/m, $N_2 = 167$ V (curve *3*). The coercive field E_c and the threshold electric field E_p change in the same way. The shift of the plot $E_c(1/d)$ with regard to $E_p(1/d)$ towards lower values of the field is connected with the applied configuration of the electrodes. The coercive field was measured in the arrangement with the silver paste electrodes, and the electric discharges were observed in the arrangement with a metal grid electrode, which short-circuit the sample at the moment when the electric discharges start.

The results show that the electric discharges at the TGS surface start when the external polarization voltage produces inside the sample the electric field of the value close to the coercive field value. This field causes the rapid domain structure reconstruction and then leads to the generation of the electric discharges at the ferroelectric surface [1, 2]. The mentioned above correlation was verified by observation of the coincidence of the dielectric hysteresis loop and the electric discharges at the ferroelectric surface (Kusz [7]), and confirmed for RS single crystals by measurements of the threshold effective electric field E_p as a function of external polarization frequency (Biedrzycki et al. [8]).

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