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The Optical Activity of Triglycine Sulfate

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Triglycine sulfate (TGS) undergoes a ferroelectric phase transition at 49°C, the point group being C_{2h} and C_2 in the paraelectric and ferroelectric states, respectively. Shuvalov *et al.*[1] predicted that the ferroelectric antiparallel domains of TGS manifest optical rotations with different signs due to their different enantiomorphic forms. One of the authors (J. K.)[2] discussed the same problem independently. Further, Shuvalov *et al.*[3] made crystal-symmetrical study of optically active ferroelectrics. Measurements of the optical activity (OA) of TGS were tried by Helmelbracht *et al.*[4] and Vlokh *et al.*[5] along its optic axis. They found that TGS is optically active in its ferroelectric state but the enantiomorphic change of the domains, which would be demonstrated by the hysteresis loop of OA with respect to electric fields, could not be proved. The previous inability of observing the hysteresis loop of OA of TGS can be considered due to the two reasons: firstly the exact measurements of OA of the monoclinic crystals such as TGS are extremely difficult since the directions of the optic axes change by temperature, electric fields and wavelengths used, and secondly OA of TGS is too small to be measured by the ordinary polarimetric methods. Evidences of enantiomorphic changes of ferroelectric domains of TGS have been given by indirect techniques,[6,7] so the direct verification using the optical activity measurement has long been awaited.

We have constructed an automatic multipurpose polarimeter which enables us to determine simultaneously the gyration tensors, the birefringence and the rotation angle of the indicatrix of a crystal along any directions.[8] Here we applied it to the problem of optical properties of TGS and successfully observed the hysteresis loop of the OA.

The measurement was made on a (010) plate specimen, 190 μm thick, with electric field E_2 being applied along [010] direction. It produced

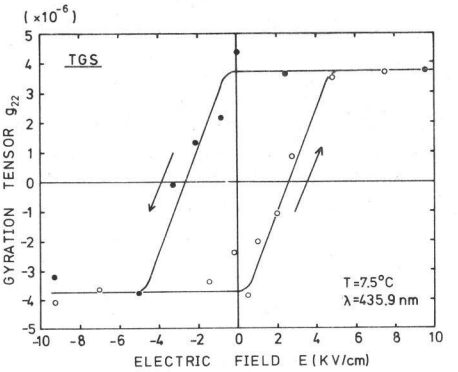

Fig. 1. Electric field dependence of a gyration tensor g_{22} of TGS at $T=7.5$°C and $\lambda=435.9$ nm.

first measurement of the gyration tensor g_{22} of TGS as function of temperature and electric field. Figure 1 depicts the electric field dependence of g_{22} at $T=7.5$°C and $\lambda=435.9$ nm in a form of small but distinct hysteresis loop. Here it is clearly dihsclosed that the antiparallel domains of TGS are anantiomorphous and that the magnitude of g_{22}, 4×10^{-6} at 7.5°C, is one order smaller than that of KDP.[9]

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