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SHORT COMMUNICATION

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Piezoelectric effect in $CdCl_2.2NiCl_2.12H_2O$.

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Abstract

For the double salt $CdCl_2.2NiCl_2.12H_2O$ the piezoelectric modulus d_{33} was measured to prove the lack of a center of symmetry. From the result of this experiment, the space group $P3$ can be attributed to this compound.

The double salt $CdCl_2.2NiCl_2.12H_2O$ is reported to belong to space group $P\bar{3}$ (*e.g.* Gmelin, 1966). Apparently, the assumption of space group $P\bar{3}$ originates from the crystal structure investigation of Ferrari & Cavalca (1946) who favored this space group. Later attempts to determine the structure failed, because the refinement calculations in neither $P\bar{3}$ nor in $P3$ lead to a satisfactory coincidence between calculated and observed intensities (Koch & Fischer, 1977). In order to check the absence of a center of symmetry, measurements of the piezoelectric effect were carried out on this compound.

The crystals were grown from aqueous solution. According to the method described by Gmelin (1966) an excess of $NiCl_2$ was added to guarantee that only the stable compound of $CdCl_2.2NiCl_2.12H_2O$ precipitated. Crystallization occurred after 28 d yielding green hexagonal platelets of 1 to 8 mm in diameter.

The table of piezoelectric moduli (Voigt, 1910) shows that there are six independent and non-vanishing moduli in the point group 3. In particular, a stress which is applied parallel to any of the crystallographic axes will produce a polarization parallel to itself. Since the crystals were grown as platelets with the main face perpendicular to the c axis, it seemed reasonable to measure the polarization P_3 parallel to **c**. In the two-suffix notation the component P_3 is given by

$$P_3 = d_{33}\sigma_3,$$

where d_{33} = piezoelectric modulus, σ_3 = stress component parallel to **c**.

For the measurements the faces were coated with silver paste and the experiment was carried out in a dry argon atmosphere to prevent the surface charge being affected by humidity. The device used will be described elsewhere. The measurements were carried out in a dynamic and a static experiment.

In the dynamic experiment, after Bergmann (1935), the crystal was excited into a longitudinal vibration by an electrodynamic vibrator. The AC signal which is produced by the piezoelectric effect at the electrodes is fed into a lock-in amplifier which also drives the vibrator. The amplified AC signal is depicted on the screen of an oscilloscope. For the double salt $CdCl_2.2NiCl_2.12H_2O$ a strong AC signal is observed which is even stronger than that of a comparable sample of quartz. This strong piezoelectric effect proves the lack of a center of symmetry.

In the static experiment a stress was applied to the crystal by a known force F causing a polarization. The surface charge Q was measured with an electrometer. The piezoelectric modulus d is determined by the relation

$$d = Q/F.$$

For $CdCl_2.2NiCl_2.12H_2O$ the modulus d_{33} was measured.

$$d_{33} = (9{\cdot}130 \pm 0{\cdot}007) \times 10^{-12}\ \mathrm{CN}^{-1}.$$

From the strong piezoelectric effect we therefore must conclude that $CdCl_2.2NiCl_2.12H_2O$ belongs to space group $P3$.

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