Short Communications

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Domain structure of Rochelle salt and X-ray reflexion.

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The existence of a domain structure in Rochelle salt, similar to that of the ferromagnetic substances, has long been assumed, but reliable experimental evidence from X-ray investigation appeared only in the papers by the present writer (Miyake, 1941*a*, *b*, 1947) and by Ubbelohde & Woodward (1946). Though a full report of my work has already been published elsewhere, this short note may not be superfluous.

My experimental procedure consisted of measuring the rocking curves of X-ray intensity reflected from many lattice planes of Rochelle salt, under various thermal, mechanical and electrical conditions, using single- or double-crystal X-ray spectrometers. The transmission method using thin crystal plates in various cuts was applied, in order to avoid the surface effect present in the reflexion method. Care was taken to control the moisture content during these measurements.

The experimental results could be fully explained by assuming the Rochelle salt in the ferroelectric state to possess a domain structure; each of the many small regions or domains is a monoclinic crystal having a spontaneous polarization P_x along the a axis and a small spontaneous deformation according to the strain component y_z, the signs (positive or negative) of these quantities varying according to the domains. Since the crystal as a whole has orthorhombic symmetry, the formation of the domain structure (which may be alternatively described as a repeated twinning of monoclinic crystals) causes an inhomogeneous strain distributed throughout the crystal. Such a strain distribution will reduce the extinction effect for X-ray reflexion, and therefore the intensity of the reflected X-rays should be generally much stronger at ferroelectric temperatures than at paraelectric temperatures at which the crystal lattice is more perfect because of the absence of domain structure. Also, the half-value width of the rocking curve would be expected greater in the ferroelectric state. These effects were actually observed in the experiments. First, by varying the temperature from 10 to 30° C. (a range including the upper Curie point, 24° C.), rapid decreases in peak intensities, integrated intensities, and in half-value widths were observed to take place at the Curie point for many lattice planes, except for the (h00) reflexions. Secondly, if an electric field along the a axis or an external stress mainly consisting of a Y_z component was applied to the crystal at ferroelectric temperatures, then the two kinds of domains would be expected to coalesce to a single domain so that the inhomogeneous strain distribution would disappear. In this case the crystal as a whole would become a more perfect lattice than in the free state, and consequently the reflexion intensity and the line breadth should decrease. These expected effects were also experimentally confirmed for many lattice planes, except for the (h00) reflexion. The reason why the (h00) reflexions do not take part in the above effects is that the inhomogeneous strain resulting from domain structure has only a y_z component, so that the regularity of the (h00) lattice plane remains undisturbed.

The above results seem to lead almost directly to the existence of the domain structure in Rochelle salt, though the size as well as the shape of the domains remain unknown. This conclusion should be compared with that of Ubbelohde & Woodward (1946). Reference could also be made to the more visual observation of domains in barium titanate by Kay & Rhodes (1947) and by Matthias & von Hippel (1948).

In conclusion, I wish to express my sincerest thanks to Prof. S. Nishikawa for his valuable advice.

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