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The Structure Analysis of Amorphous $PbTiO_3$ by the Energy Dispersive X-Ray Diffraction

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The amorphous $PbTiO_3$ was prepared by the roller quenching method[1] from the melt of crystalline $PbTiO_3$ containing 0.5 mol % B_2O_3. Each piece of samples was about 10 μm thick and 0.3 cm^2 in area. The X-ray diffraction pattern was observed by the energy dispersive method, because the measuring time is relatively short and the scattering parameter $s=4\pi \sin\theta/\lambda = 4\pi \sin\theta\ (E/hc)$ can easily be made high. A tungsten X-ray tube was used as a source and operated at 50 kV and 10 mA. The detector was an intrinsic Ge solid state detector. The energy range used in the analysis was from 17.9 to 47.3 keV so as to avoid the energy near the absorption edge of Pb (15.86 keV). The Bragg angles θ's were chosen on the condition that the range of the scattering parameter observed at one angle is made as wide as possible with some overlap of the parameter and that the maximum parameter of about 19 $Å^{-1}$ is obtained. The observed pattern is shown in Fig. 1.

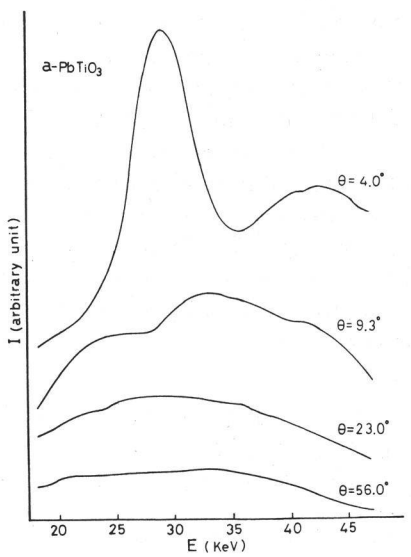

Fig. 1. The experimental intensity distributions at $\theta=$ 4.0°, 9.3°, 23.0°, 56.0°.

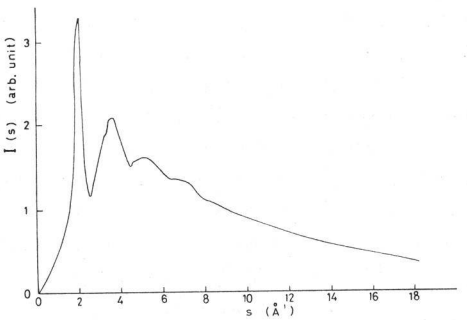

Fig. 2. The total diffraction pattern corrected for the intensity distribution and polarization of the incident beam and absorption in the sample.

The data was analyzed following the work of Prober *et al.*,[2] with some modifications. The diffraction pattern at $\theta=56°$ was taken to get the information on the incident beam spectrum. The total diffraction pattern $I(s)$ is shown in Fig. 2, which is corrected for the absorption in the sample and for the intensity distribution and the effect of the polarization of the incident beam, and also normalized at $s=15$ $Å^{-1}$ where the inter-atomic correlation was assumed to disappear. This pattern shows that the sample is amorphous. The structure function obtained from $I(s)$ is not reasonable, because it has negative value at small s. One of the reason of the negative value is in the sample, because some voids having the radius of about 5 μm were found in the sample by the scanning electron microscopy and the surface of the sample was not flat enough. However, it is obtained from the first peak in the radial distribution function that the nearest Pb-Pb distance may be slightly shorter than that in the crystalline $PbTiO_3$.

References

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2) J. M. Prober and J. M. Schultz: J. Appl. Cryst. **8** (1975) 405.