

X-RAY TOPOGRAPHIC INVESTIGATIONS OF DOMAIN STRUCTURE IN CZOCHRALSKI GROWN $\text{Pr}_x\text{La}_{1-x}\text{AlO}_3$ CRYSTALS

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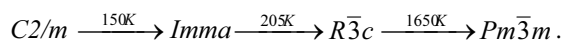
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Praseodymium lanthanum aluminium perovskite is interesting in view of the complicated phase transitions, some of them ascribed to ion lattice coupling. One of the aspects of the interest is connected with the preparation of crystals with self-organized domain structure with possible application in light guiding [1]. The open problem in the technology of these crystals is the characterization including examination of the regularity and crystallographic features of the domain structure, and the presence of common crystallographic defects, as dislocations and inclusions.

In the present paper we attempted to apply the X-ray diffraction topographic techniques exploring both synchrotron and conventional X-ray sources to a number of samples cut out from Czochralski-grown $\text{Pr}_x\text{La}_{1-x}\text{AlO}_3$ crystals with different ratio of praseodymium and lanthanum. The investigated crystals included both the cases, when praseodymium replaced part of lanthanum atoms, or was introduced as a dopant.

It is well known, that PrAlO_3 similarly as LaAlO_3 is a rhombohedrally distorted perovskite (space group $R\bar{3}c$, tilt system $\bar{a}\bar{a}\bar{a}$) [2, 3]. The phase transition of PrAlO_3 can be described as



The majority of the investigated samples contained extended domain structure, expected to be a result of twinning with $\{100\}$ invariant twin planes. The domains are visible using the optical microscopy equipped with polarizers, or with Nomarski phase contrast, but some fine details of the domains were previously studied with the FM method [1]. The width of the particular domains was in the range from tens to hundreds of micrometers.

The synchrotron X-ray topographic experiments were performed using white synchrotron beam mainly in back reflection geometry and only to some selected sample the transmission X-ray topography was applied. The conventional X-ray Lang topographs were taken for a number of samples selected from parts of the crystals with relatively low concentration of defects.

The synchrotron white beam topographs usually reproduced the domains as series of mutually displaced stripes corresponding to different orientation of

the crystal inside the domains. The density of domains was different in the samples cut out from various crystals with different composition, but generally it was most numerous in the case of crystals with highest concentration of praseodymium. In this case, the synchrotron topographs usually revealed sets of domains corresponding to more than one system of twinning. It is also probable that in the case of most dense domain structure the stripes revealed by the topographs correspond rather to some sets of domains than single domains. The representative topograph of a sample with such a dense domain structure is shown in Fig. 1.

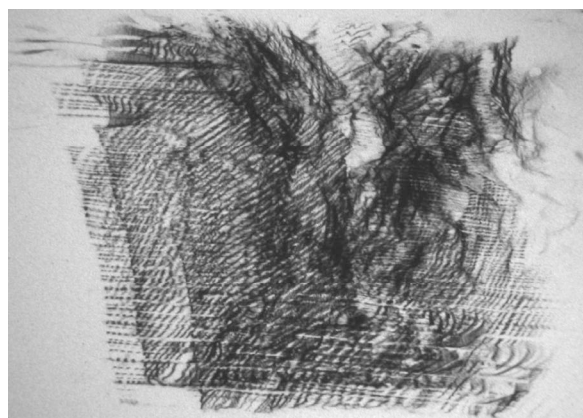


Figure 1. The representative white beam back-reflection projection topograph of the sample cut out from $\text{Pr}_{0.75}\text{La}_{0.25}\text{AlO}_3$ crystal with extended domain structure.

The samples with low concentration of praseodymium contained large single crystal regions, where it was possible to reveal the individual dislocations and the segregation fringes.

References

- [1] D.A. Pawlak, T. Łukasiewicz, M. Carpenter, M. Malinowski, R. Diduszko, J. Kisielewski, *J. Cryst. Growth* **282** (2005) 260.
- [2] A.M. Glazer, *Acta Crystallogr. B* **28** (1972) 3384.
- [3] A.M. Glazer, *Acta Crystallogr. A* **31** (1975) 765.