Synchrotron topographic studies of domain structure in Czochralski grown $Pr_xLa_{1-x}AlO_3$ crystals

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The real structure of $Pr_xLa_{1-x}AlO_3$ (x = 1, 0.75, 0.55, 0.4 and 0) and $LaAlO_3$ doped with Pr single crystals was characterized with a number of methods including conventional and synchrotron X-ray diffraction topography, and polariscopic micrography. The surface of the samples has been also investigated with a high resolution profilometer.

The crystals were grown by Czochralski technique [1]. High purity Pr_6O_{11}, Al_2O_3 and La_2O_3 oxides (99.995%) were used as raw materials. All components were mixed in stoichiometric ratios. The pulling and rotation rates were in the range of 1-1.7mm/h and 6-8 rpm. The crystals have been grown in pure nitrogen atmosphere. The samples were cut out perpendicularly to the <100> pseudo-cubic axis closest to the actual growth direction.

The presently applied sample orientation allowed precise recognition of domain systems, and determination of the orientation of the lattice connected with the domains.

It has been confirmed that the domains are of a twin character, similar as it was described by Dudley and Yao in $LaAlO_3$ and $LaGaO_3$ crystals [2]. In those crystals the twin configuration and their changes were studied as a function of temperature in the vicinity of phase transition temperatures .

The domain systems, observed by us, were investigated in $Pr_xLa_{1-x}AlO_3$ (for different x) and in $LaAlO_3$ crystals doped with Pr , and their appearance and configuration were compared for samples, containing different amount of Praseodymium. The observed twin domains systems were located along <100> and <110> (pseudo-cubic) directions. The evaluated changes of the lattice orientation depend on the chemical composition of the samples. The representative back-reflection white beam synchrotron radiation topograph of the $LaAlO_3$ crystal is shown in Fig.1. The important advantage of the white beam transmission section topography was the possibility of proving that the domain systems are perpendicular to the sample surface (Fig.2).

The details of the domain structure were well revealed in polariscopic micrographs. It was also possible to reveal them by means of the profilometer. The observed surface relief is most probably caused by different mechanical or chemical polishing of differently oriented materials inside the domains.

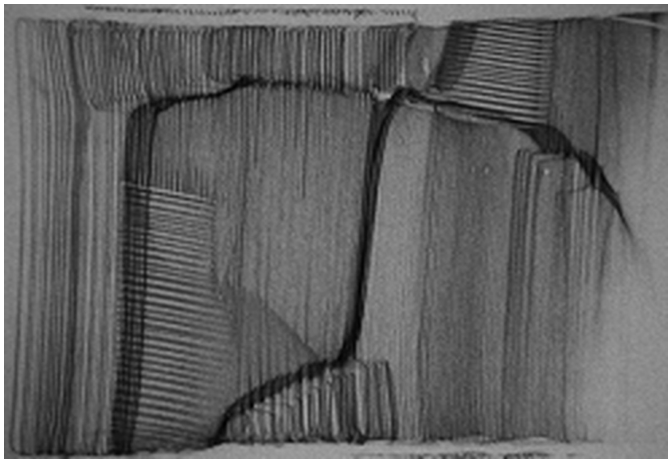

Figure 1. The representative projection back-reflection topograph of the $LaAlO_3$ revealing the domain structures along two perpendicular planes.

Figure 2. The transmission white beam section topograph of the $LaAlO_3$. The vertical location of the domains proves their perpendicularity to the surface of the sample.

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References

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