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Process Dislocations in Hydrothermal Zinc Oxide Crystals

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Beamline(s): **X19C**

Introduction: Zinc oxide (ZnO) is a wide band-gap semiconductor with an energy gap of 3.37 eV with potential for applications as emitter devices in the blue to ultraviolet region and as a substrate material for GaN based devices [1]. It has the highest shear modulus and stable lattice because of the small inter-atomic distance among the II-VI semiconductors. High quality ZnO single crystals are required for different applications. Synchrotron White Beam X-ray Topography has been used to study these crystals

Methods and Materials: ZnO crystals have been grown using platinum lined high strength steel autoclaves at 355°C with temperature differential of 10°C. The mineralizer solution was made of Li_2CO_3, KOH and NaOH. The nutrient was prepared from 99.99% ZnO. Crystal growth was carried out on (0001) cut seed plate. Crystal plates cut perpendicular to 'c' direction were polished. The crystal sample was mounted on a goniometer and was aligned using back reflection Laue diffraction. Topographs of different reflections were recorded by scanning in white beam synchrotron radiation.

Results: Topograph in Figure 1 shows the slip bands observed on (0001) crystal slice. Apparently no growth dislocations could be observed in this configuration. However growth dislocation could be observed by the complementary etching technique. Micro-indentations were done on these (0001) crystal slices using Vickers diamond tip and studied by the x-ray topography. In general it showed strain pattern with six fold symmetry at the indented region. At higher loads (500 gms and above) it generates slip bands around the indented region.

Conclusions: The topograph taken on (0001) slice reveals the presence of process induced slip bands. These are due to the presence inclusions. These slip bands occurred mainly due to the differential thermal expansion between the inclusions and the bulk. X-ray topography of micro-indented (0001) ZnO slice revealed the fact that the applied load should exceed a threshold to generate slip bands due to indentation.

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References:

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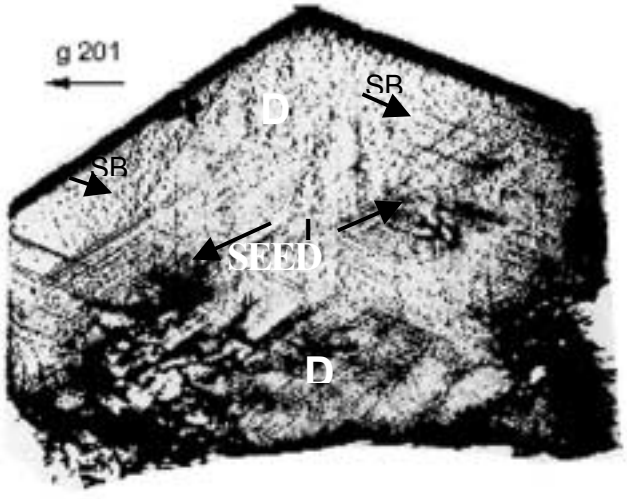

Figure 1. Topograph of (0001) slice revealing slip bands induced by inclusions. SB – Slip bands; I – Inclusions