Sintered nanocrystalline GaN and nanocomposites SiC-GaAs were investigated using X-ray imaging at the beamline G3. The aim of the experiment was to determine how uniform were the samples at the micrometer scale.

GaN samples were prepared using nanocrystalline powders synthesized by either conversion or aerosol methods [1, 2]. They were sintered at pressure of 8GPa and at several temperatures near 900°C [3]. The sintering conditions chosen cause a limited grain growth during the sintering process.

Nanocomposites SiC-GaAs were prepared by infiltration of liquid GaAs into a porous matrix made of nanocrystalline SiC powder [4]. Processing conditions were 8 GPa and 1200°C.

Figure 1: Investigated GaN samples (diameter 5mm): a sum of intensities of x-ray images at the top of (002) peak (2θ from 35.45 to 35.65) and diffractograms of marked areas.

The images of 3 GaN samples obtained at the (203) diffraction peak are shown in fig. 1 along with the corresponding diffraction patterns. Samples A and B appear to be uniform. This allowed us for accurate grain size determination by independent high resolution diffraction measurements.
The sizes were determined to be: 120 nm for sample D and 11 nm for sample C. In A/B sample two types of structure are found: bright areas with large grains and dark areas with small grains. Accurate determination of the grain sizes in the two types of areas could not be done because of insufficient resolution of G3 instrument in the imaging mode. Those sizes could be estimated as greater than 50 nm in bright areas and about 15 nm in the dark areas. The direct reason for the difference in the grain growth rate in different parts of the samples could be an inhomogeneous composition of the starting powders. It should be noted that in the bright areas the GaN peak is accompanied by a weak Ga$_2$O$_3$ peak. A tentative explanation for the grain growth in those parts of the samples could therefore be enhanced mass transport through the molten Ga$_2$O$_3$.

Figure 2: X-ray images taken at the (002) diffraction peak of SiC (upper) and (002) peak of GaAs (lower).

The images of SiC-GaAs nanocomposites obtained at the (002) diffraction peak of SiC and (002) peak of GaAs are shown in fig. 2. In the dark parts there is low GaAs deficient. The reason for this non-uniform structure is yet to be determined.

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References