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Photoluminescence topography of fluorescent SiC and its corresponding source crystals

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High power and high efficiency electrical as well as opto-electrical devices need homogeneous SiC substrates of high quality for maximum performance. A promising method for substrate preparation is the Fast Sublimation Growth Process (FSGP), using poly-crystalline SiC (pc-SiC) source material. The source is important since it provides the dopants and is the growth rate determining step [1]. Due to the morphology and polytypism of the pc-SiC, the incorporation of the dopants in the source material varies in a wide range. In this work we investigated the effect of source structure on the homogeneity of the epitaxial layer and its fluorescent properties.

We measured the source crystals and the grown epitaxial layers by photoluminescence (PL) topography at the energy of the Donor-Acceptor-Pair (DAP) recombination in 6H, which is equivalent to 560 nm. A 405 nm laser-diode was used for excitation. A PVT growth method [2] was used to prepare the source-crystals to fabricate two types of samples which were co-doped with boron at 100 ppm (sample 1) and 50 ppm (sample 2), respectively, at a constant N2 flow of 10 sccm. .

The topograms clearly show an inhomogeneity in luminescence for the pc-SiC source crystal which correlate with their grain structures (Fig. 1a+b and Fig. 2a+b). Sample 1 shows a direct correlation between polytype and luminescence intensity. Nearly all areas with high luminescence at 560 nm are 15R-SiC. Only the dark tinted regions show higher luminescence whereas the lightly tinted regions show much less intensity.

In Sample 2 it is not possible to correlate the luminance with the polytype, though the variation in luminance has to describe the variation in the dopant concentration. This correlation was already shown in Ref. [3]. The grain structure of the source crystal can be seen in Fig. 2a. Fig. 2b shows the corresponding PL-topogram. In comparison to sample 1, 15R-SiC does not result in the highest luminescence intensity which has to be due to the different doping concentrations. The luminescence is influenced by the dopant concentrations and the ratio between N and B [4].

The picture of the grown epitaxial layer of sample 1 and its PL-topogram are shown in Fig. 1c and d, respectively. We observed a very homogeneous distribution of luminescence intensity which is equal to a homogeneous distribution of the dopants even though there are various polytype grains in the source. The higher luminescence intensity in the middle of the sample is due to a higher film-thickness. This film is almost completely 6H-SiC but has a small inclusion of 3C-SiC in the lower left corner visible as a dark spot in the luminescence topogram (Fig. 1d).

The other sample, shown in Fig. 2c and d, has much more 3C-SiC inclusions in the epitaxial layer due to the use of a low off-axis substrate [1]. There is no correlation between the 3C formation and the source crystal structure. Due to the high amount of 3C inclusions the homogeneity of the dopant distribution over the whole sample cannot be observed.

In summary: The granular polytype variation of the source material does not affect the homogeneity of the spatial luminance of the FSGP epitaxial layer. Defects in the epitaxial layer, in particular 3C-SiC inclusions, are attributed to general FSGP growth parameter variations rather than to the morphology of the poly-SiC source material.

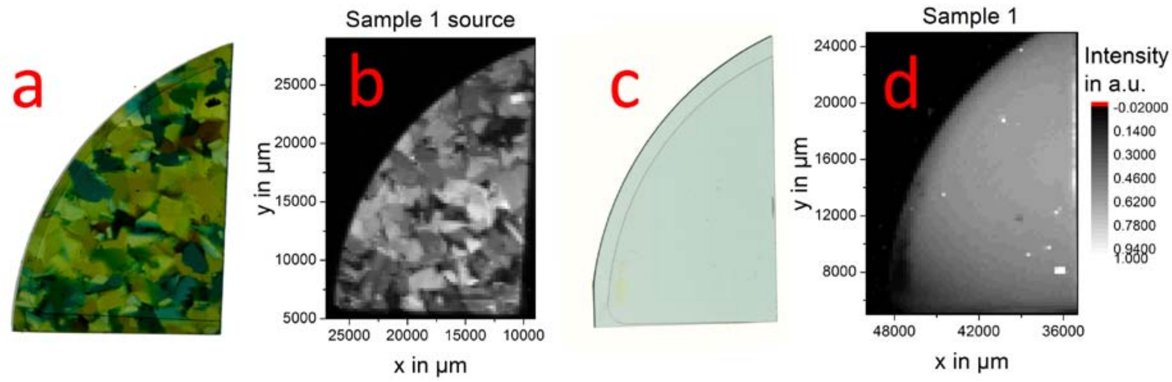

Fig. 1 a) Source used for sample 1 and its corresponding PL-topogram at 250 µm resolution (b), c) Epitaxial layer of Sample 1 and its corresponding PL-topogram at 250 µm resolution (d), c and d are mirrored for easier comparison

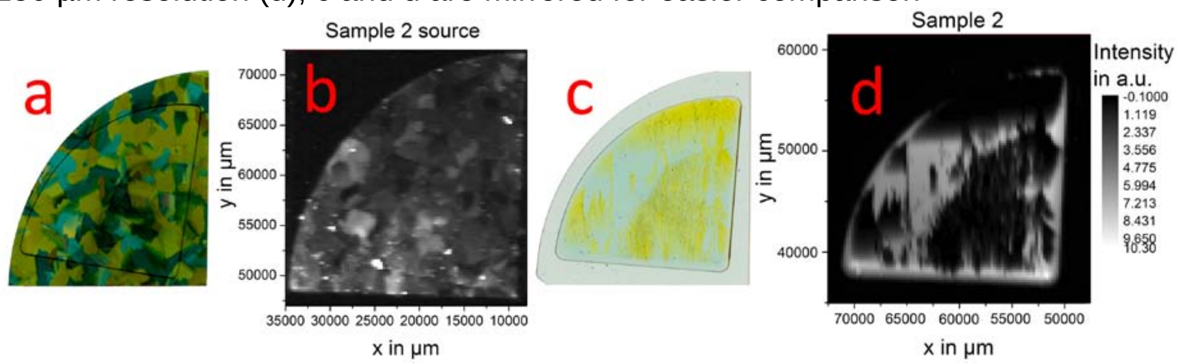

Fig. 2 a) Source used for sample 2 and its corresponding PL-topogram at 250 µm resolution (b), c) Epitaxial layer of sample 2 and its corresponding PL-topogram at 250 µm resolution (d), c and d are mirrored for easier comparison

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