

Electron Tomographic Characterization of Er doped SiC

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Small transition metal crystals embedded in a semiconducting matrix are nanostructured systems with potential applications in fields such as spintronics. However, before application related questions can be addressed, basic questions on the nanocrystal formation process have to be answered.

In the past we studied the nanocrystal formation process of hill-like shaped ErSi₂ nanocrystals formed after high dose Er ion implantation in 4H-SiC by HAADF-STEM imaging and spectroscopy and we suggested that the nanocrystals start to form at matrix defects, rather than to grow spontaneously [1]. However, the crystal shape within the volume could not be derived from two-dimensional imaging but by HAADF-STEM tomography [3]. Using iterative reconstruction techniques, it was not only possible to visualize faceting of the nanoparticles with a diameter of 1-25 nm, but also erbium decorated voids and channels filled with Er atoms (see Figure). After detailed analysis of the tomogram, the crystallographic shapes and facets of the particles as well as the location of erbium decorated channels pointing to the nanocrystals could be determined. In this way, our prior understanding of the nanocrystals' shapes, as hill-like with a more round base in the (0001) SiC plane viewed along the [11-20] SiC projection [2], had to be renewed. We found out that their basal plane typically exhibits strong hexagonal faceting corresponding to {1-10l} planes in SiC. Both their shape and orientation stay the same throughout most of the sample; nanocrystals exhibiting {11-2l} type facets are observed only occasionally.

In this work we concentrate in more detail on the visualization and orientation of the small Er decorated channels in the matrix volume. These channels are found in the Er rich region of the sample only and are typically oriented along the <1-100> direction of SiC. We suggest that they are diffusion channels and discuss their significance for nanocrystal formation.

References:

- [1] U. Kaiser, D.A. Muller, J.L. Grazul, A. Chuvilin, M. Kawasaki, *Nature Materials* 1 (2002) 102.
- [2] U. Kaiser, D.A. Muller, A. Chuvilin, G. Pasold, W. Witthuhn, *Micr. and Microanal.* 9 (2003) 36.
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Figure: (left) three-dimensional view on ErSi_2 nanocrystals embedded in a crystalline SiC matrix (reconstructed volume); (right) view of the nanocrystals in the x-y section (original image); note the decorated channels associated with the nanocrystals.

