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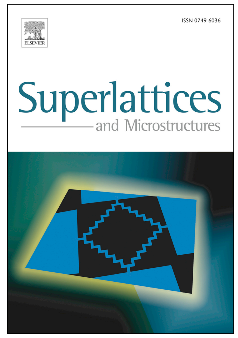

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E.B. Yakimov, E.E. Yakimov, V.I. Orlov, D. Gogova

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Some new insights into the impact of annealing on single stacking faults in 4H-SiC

E.B. Yakimov[1,3], E.E. Yakimov[1], V.I. Orlov[1,2], D. Gogova[4]

[1]Institute of Microelectronics Technology RAS, Chernogolovka, 142432, Russia
[2]Institute of Solid State Physics RAS, Chernogolovka, 142432, Russia
[3]National University of Science and Technology MISiS, Moscow, Russia
[4]Central Laboratory of Solar Energy and New Energy Sources at the Bulg. Acad. Sci., Tzarigradsko shose 72, 1784 Sofia, Bulgaria

Highlights

- Enhanced excess carrier diffusion along stacking faults is observed.

- Gliding of C- and Si-core 90° partial dislocations under annealing is demonstrated.

- 30° partial dislocations driving the SSF expansion can reverse the gliding direction under annealing.

Abstract

The impact of annealing in the 350-500°C temperature range on the stacking faults, generated by electron beam irradiation of 4H-SiC crystals, have been studied. We have demonstrated that the partial dislocations driving the stacking faults expansion are also mobile under annealing and lead to shrinking of stacking faults. Gliding of 90° partial dislocations with both C- and Si-core is detected after annealing. It is observed that SSFs introduced from indentation by annealing have not pronounced crystallographic orientation that can prevent their expansion under subsequent electron irradiation. An anomalous excess carriers transport along the stacking faults at distances of 10 and 50 μm in highly- and low-doped 4H-SiC is detected.

Keywords: 4H-SiC, stacking fault, LEEBI, cathodoluminescence, partial dislocations

Introduction

The 4H polytype of SiC (4H-SiC) is a wide band-gap semiconductor highly advantageous for production of bipolar power devices with a high breakdown voltage employed in a number of applications. However, the fabrication of such devices is currently impeded by formation and expansion of Shockley-type stacking faults (SSFs) during the forward-bias operation, which significantly increases the resistance to forward current [1-6]. Therefore, this phenomenon has drawn the attention of many researchers, however, in spite of numerous investigations many fundamental questions still remain to be explored. In particular, the detailed mechanisms of SSF nucleation and the driving force for their expansion are yet not fully understood. The expansion of SSFs under excess carrier injection is driven by the recombination-enhanced partial dislocation glide (REDG), which allows them to overcome the Peierls periodic potential at room temperature. The "effective" driving force necessary for the dislocation glide is determined by the competition between the energy decrease due to electron capture into quantum wells associated with the SSFs (so-called "quantum well action") [6-10], and the SF formation energy. It was widely assumed that the energy gain due to carrier capture can be higher than the SF formation energy, therefore, the "effective" formation energy of SFs can be negative at least at room temperature. As shown in [11-13], the SSF expansion under excess carrier injection at room temperature can be reversed by annealing at temperatures higher than 210°C, which has