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Quantitative Characterization of Defects in V-doped SiC Wafer using Image Analysis Technique

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Abstract:

Semi-insulating silicon carbide (SI-SiC) wafer is considered to be the key substrate material for developing SiC-and GaN-based high-frequency, high-power electronic devices. For defect analysis of SiC crystals, a large quantity of various microscope, SEM and TEM images are taken routinely. However, most images are only used for visual inspection due to the difficulties in quantitative characterization. Analysis results are very subjective because they are mainly judged by personal knowledge and experience. It is highly desirable to develop accurate and user-friendly image processing software to reduce or eliminate individual errors and enhance efficient utilization of image data.

In this study, we prepared vanadium doped semi-insulated single crystal SiC wafers and defects were characterized. The single crystal SiC wafers were etched with molten KOH solution at 450 °C for 12 minutes. Several optical microscope and SEM images were taken before and after molten KOH etching. A newly developed, unified image processing software (PicMan from WaferMasters, Inc.) is used for quantitative analysis of defects in V-doped SiC wafer images.

Area of defect A, B and C were measured to 19.5 μm^2 , 15.7 μm^2 and 9.9 μm^2 before etching and 33.0 μm^2 , 27.7 μm^2 and 22.2 μm^2 after etching, respectively. The area of defects was increased in 68%, 76% and 124% after etching. The areal etch rate of defect A, B and C were estimated to be 1.11 $\mu\text{m}^2/\text{min}$, 1.00 $\mu\text{m}^2/\text{min}$ and 1.13 $\mu\text{m}^2/\text{min}$. The areal etch rate of three defects was similar despite the size and shape were different. This indicates that the nature of defects is similar (Vanadium precipitates). It is confirmed that three defects were originated from Vanadium precipitates using by the EDX analysis before etching step.

The defects on V-doped SiC wafer surface after molten KOH etching was quantitatively characterized using the image processing software (PicMan).

Keywords

Silicon Carbide, Semi insulating, Defect, Image Processing Software

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