

Preliminary study on trace element analysis for volumetric silicon carbide sample by instrumental neutron activation analysis

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In developing next-generation power semiconductors, the silicon carbide (SiC) is one of the most important materials with the high thermal conductivity, high breakdown voltage and fast switching time compared to the silicon-based semiconductors. In order to develop a technique for the growth of the high purity and large-area SiC ingot, it is necessary to quantitatively determine the trace elements in the ingot, which is very important information for the quality control and improvement of the growth process. For this purpose, in the present study, a analysis technique was developed for the volumetric SiC sample based on the instrumental neutron activation analysis (INAA). First, we determined the detection efficiency of the high purity germanium (HPGe) detector for gamma-rays emitted by the irradiated volumetric sample. To calculate the detection efficiency, an in-house program based on the Geant4 simulation toolkit was developed, and it was confirmed that the efficiency can be predicted within 10% relative error for the gamma standard source. For the INAA of the SiC, the cylindrical sample ($r = 1$ cm, $H = 1.13$ cm) filled with the SiC powder (BAM-S008, 1.27 g) was irradiated at the Dalat research reactor with the thermal neutron flux of $4.14 \times 10^{12} \text{ cm}^{-2} \cdot \text{s}^{-1}$ for 15 min and the gamma-ray spectrum of the volumetric sample was measured. With the developed program, the detection efficiency for the cylindrical sample was calculated and then, the trace elements in the sample were determined. By compared with the previous result, it was confirmed that trace elements in the volumetric sample can be determined by the developed method. The technique developed in this study will be used to analyze the large volume and high purity SiC sample in order to improve the detection limit of the INAA.

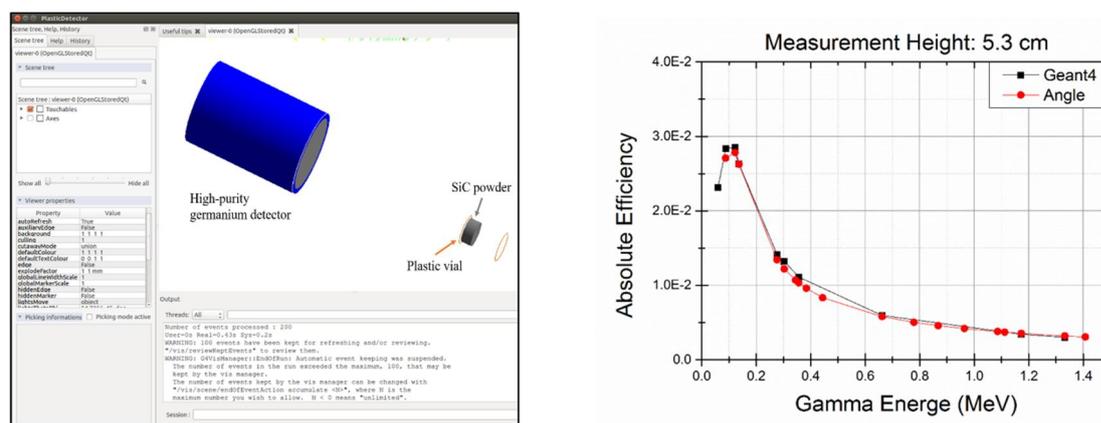


Fig. 1. Geant4-based in-house program for the calculation of the detection efficiency (left) and calculated efficiencies for the volumetric SiC sample using the in-house program and ANGLE program (right)

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