Investigation into carbon supply in top seeded solution growth of SiC bulk crystals

Minh-Tan Ha¹,², Myung-Hyun Lee¹, Younghee Kim¹, Cheol-Jin Kim², Won-Jae Lee³, Seong-Min Jeong¹,ⅹ

¹Energy and Environmental Division, Korea Institute of Ceramic Engineering and Technology, Jinju 52851, Korea
²Department of Ceramic Engineering, Gyeongsang National University, Jinju 52828, Korea
³Department of Materials and Component Engineering, Dong-Eui University, Busan 47340, Korea

E-mail: ⅹsmjeong@kicet.re.kr

Top seeded solution growth (TSSG) of SiC single crystals has been known as a potential method to achieve high quality SiC bulk crystal[1]. In this method, the seed crystal is located on top of a carbon-dissolved silicon-rich solution at high temperature, then the crystal grows by the precipitation of solid SiC from the solution and the carbon concentration is the most important factor influences the crystal growth rate[2]. There were numerous studies on increasing the carbon solubility by adding transition metals to the solution[3] or concentrating carbon flux near the seed surface by forced convection techniques[4]. However, the conventional carbon source for the solution is the graphite crucible, the reservoir of the solution, so when increasing the carbon solubility, there are some side-effects could occur, such as decrease of crucible durability, especially in long-term growth. By adopting inert crucible as the Si reservoir in the TSSG method, the degradation or eroding of crucible during crystal growth could be overcome.

In this study, therefore, we evaluated the material effect of crucible with a graphite block inside the solution as the carbon source. By the addition of the graphite block, the transportation of carbon in the solution also was simplified and well studied. In this case, the carbon source, a graphite block, is always immersed in the solution so the supplying of cabon from the block is uniform and continuously regardless the change of the solution level due to vaporization. By adopting inert crucible without any reaction between Si liquid and crucible material, the dissolving rate of carbon from the block and the growth rate of the crystal were assumed to be equal to stabilize the carbon concentration during crystal growth. To investigate the material effect of crucible, SiC and W crucibles were prepared to be compared with conventional graphite crucible. The experiment parameters, crucible and graphite blocks designs were optimized by multiphysics simulation with COMSOL®[5] as demonstrated in Fig. 1a) and b). SiC crystals were grown on off-axis C-face 4H-SiC seeds at 1800 °C, then the durability of graphite crucible and the grown crystal quality by long-term growth were evaluated using several characterization techniques as shown in Fig. 2.

References


* corresponding author


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**Fig. 1.** a) The design of inert crucible, immersed graphite block; b) The modeled temperature profile by COMSOL multiphysics

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**Fig. 2.** a) A plain view, b) an OM image, c) Raman spectrum and d) rocking curve of a sample grown at 1800 °C