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Growth of SiC single crystal under various PVT process condition

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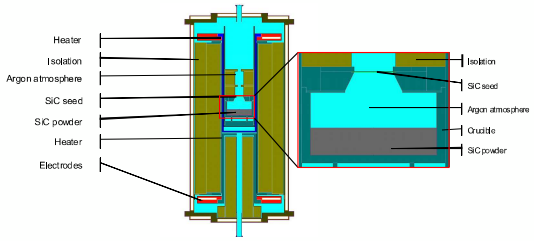
Abstract

In these studies the results of numerical modelling and experimental investigations of 6H-SiC single crystals growth are presented. The growth kinetics has been analysed for different reactor geometry as well as for various thermal and pressure conditions. The processes calculated numerically were consistent with experiments, where bulk SiC single crystals have been obtained. The geometry of the reactor is presented schematically in Fig. 1.
The first part of the studies performed here was devoted to optimization of thermal conditions in the crystallization front. This was realized by design of the geometry of the isolation over the SiC single crystalline seed. It was found that the temperature profile on the crystal surface can be controlled by the geometry of the clearance in the isolation over the seed. This kind of optimization enabled for shaping the first stage of the growth process related with nucleation.
In the second part of these investigations the influence of temperature (including temperature gradients) and pressure on the growth rate and the shape of crystallization front has been studied. One of the example result presenting the effect of argon pressure on the crystal growth rate is shown in Fig. 2.

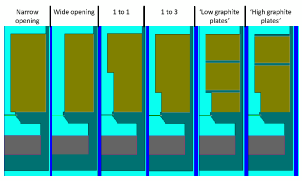
Reactor geometry

Figure 1

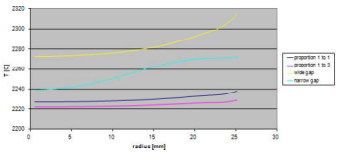


The influence of insulation

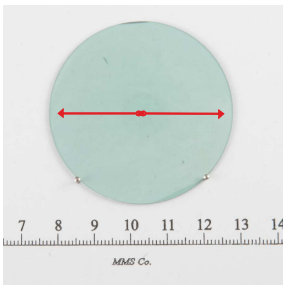
Insulation geometry

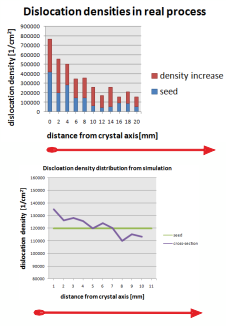


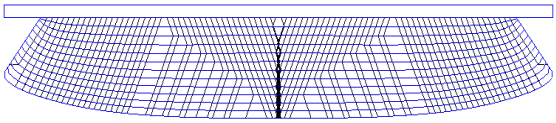
Seed surface temperature



Defects density





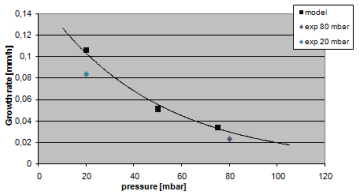


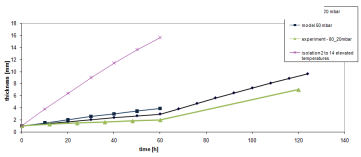
Model of dislocations in cross-section generated by computer program "virtual reactor"

Growth kinetics as a function of process conditions

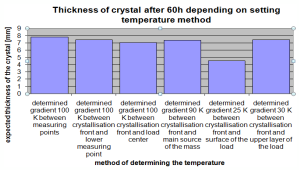
Growth rate vs pressure

Figure 2





Growth rate vs temperature



Summary

The results obtained by modelling were verified by characterization of bulk crystals obtained experimentally. It can be noticed that growth kinetics can be predicted by modelling with sufficiently good accuracy. The evolution of the crystallization front shape during the process can also be identified by numerical simulations. Sequential addition of nitrogen during the growth process in the experimental part enabled for verification of the shape of the crystallization front obtained by modelling. In this case, results of modelling and experiments are in a good agreement.

Since the experimental characterization of the SiC growth process is strongly limited, mainly by the severe conditions (high temperature), the modelling methods enables for closer look into evolution of the crystal, mass and heat transfer in the reactor. This enables for better understanding of the growth process and further optimization of the reactor geometry and process conditions.

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