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A simplified finite element model for numerical simulation of temperature field and optimization of parameters in single crystal growth by optical floating zone technique

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Abstract

Optical floating zone (OFZ) is one of the most extensively used techniques to grow a variety of bulk crystals, especially single crystals of metal oxides. Although the growth parameters have been identified to be the nature of feed rod, lamp power, rotation rate, growth atmosphere and gas pressure, etc., few studies revealed the effects of these parameters on temperature field during crystal growth in image furnaces. It is well known that the temperature gradient is the driving force for float zone crystal growth. Therefore, it is essential to obtain the major growth parameters affecting OFZ temperature field. In this work, a simplified finite element (FE) model was developed for numerical simulation of temperature field during OFZ crystal growth. The effects of major growth parameters (i.e. lamp power, lamp filament, and molten zone geometry) on temperature field during OFZ crystal growth were hence identified theoretically and validated experimentally. According to the numerical calculation, the growth parameters were optimized and high-quality TiO₂ single crystal was grown in practice. Prospectively, the FE model presented in this work can be applied to optimize growth parameters for other crystals as well as opens up new opportunities to understand the physical process of OFZ crystal growth in a simple and scientific way.

Keywords

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