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Three-dimensional computations of the hydrodynamics and mass transfer during solution growth of KDP crystal with a planetary motion

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Abstract

Computational analysis of the three-dimensional flow and mass transfer involved in the growth of KDP crystal with a planetary motion (PM) was conducted, in which the crystal executes an orbital revolution with a constant revolution rate during its self-rotation together with periodically changing the direction of crystal rotation. Compared with the conventional KDP growth method which conducts centric rotation (CR), this new configuration can avoid the sharp fluctuation of surface supersaturation during the phases of crystal spin down, stalling and spin up, and brings about an oscillatory fluid field during the steady self-rotation phase, all of that being able to promote the morphological stability of the growing crystal. By increasing the self-rotation rate, the frequency of the oscillatory fluid field will increase, and the morphological stability will be enhanced. The time-averaged supersaturation fields of the crystal surfaces are obtained, which are greatly affected by the orbital revolution rate and the orbital radius. For a higher orbital revolution rate or larger orbital radius, higher time-averaged value and better homogeneity of the surface supersaturation could be obtained.

Keywords: A1. Computer simulation; A1. Fluid flows; A1. Growth models; A2. Growth from solutions; A2. Single crystal growth; B1. Phosphates

1. Introduction

A growing energy shortage in the world today makes it very necessary for scientists to do much research in laser-induced thermonuclear fusion. At present, KDP and DKDP crystals are the only electro-optic crystal materials applied in the plasma-electrode Pockels cell which is used in the laser-induced thermonuclear fusion as an optical switch for 2ω and 3ω conversion [1]. It is of practical and scientific significance to develop a method for rapidly growing KDP crystals with large scale and high quality.

Over the past 80 years, scientists and technologists have done much research on the structure, properties and growth method of KDP crystals, which improve the growth rate and optical performances of the grown crystals. Especially during the