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Group growing method of sapphire crucibles and boats

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Growing methods of sapphire articles having variable cross-sections from melt by Stepanov technique have been considered. The growing method effect on the pore distribution in the articles has been studied. A growing method has been proposed for covers and crucibles with optically transparent bottoms.

Исследованы способы получения из расплава методом Степанова сапфировых изделий с переменным сечением. Изучено влияние способа выращивания на распределение пор в изделиях. Предложен способ получения чехлов и тиглей с оптически прозрачным дном.

Recently, an interest in shaped sapphire articles of complicated profiles rises in addition to demand for simple shape products (tubes, strips, rods, etc.). In various engineering applications, articles with optically transparent bottoms are required. Those are expensive to made by machining, and in some cases this is impossible at all. The purpose of this work is to study and develop various Stepanov (EFG) technique modifications for manufacturing of sapphire covers, boats, crucibles, and other variable profile articles.

A method including relative displacement of the shaping head (die) mobile parts was proposed for manufacturing of sapphire articles with blind holes [1]. According to [2], the use was made of the melt column spreading over the continuous top surface of the die at the annular melt feeding. A combination of both above techniques is also known [3]. In [4], an apparatus has been proposed for growing of shaped crystals with internal voids. The crucible walls and bottom were grown alternately by the die top filling with the melt using vacuum. To produce hollow articles, the variable shaping technique was elaborated [5] that expanded substantially the possibility of the growing crystal geometry control.

The main drawback of the mentioned methods consists in the die design unreliability and intricacy due to the use of mobile elements and the shape-setting assembly where the crucible and die are separated from each other. The use of the crucible displacement inside the heating zone is also very undesirable, in particular, in growing units with induction heating, since this may cause a change of thermal conditions within the growth zone. In such apparatus, it is impossible to obtain sapphire crucibles with planar internal bottom surface free of pores and inclusions.

The sapphire articles were grown using a Kristall-606 unit with induction heating under argon atmosphere (1.1 to 1.3 atm pressure) at a rate of 20 to 50 mm/h. The process was monitored using a TV system with 20× magnification. To manufacture the articles, the profile elements were grown alternately using two dies arranged side by side (Fig. 1). The separable dies 3 were mounted on the top of the capillary system (pedestal) 2. Two dies 3 with annular melt feeding were used in the version shown in