V. A. Tatarchenko. *Profiled crystals: growth and applications.* The growth of single crystals of controllable size and shape is an important scientific and technological problem, since the availability of single crystals of metals, semiconductors, and insulators in the form of tubes, tapes, and other, more complicated, profiles will make it possible to develop new devices of various degrees of complexity at the frontiers of technological development.

Most of the specific methods for producing profiled crystals which are used in the Soviet Union and abroad are based on the Stepanov method, which was proposed back in 1938.[1] The idea underlying this method is to put a solid—a shaper—in the melt to give the column of melt a certain shape. By then crystallizing a column of melt to a certain height one can produce a crystal with a specified cross section.

1. *Theoretical analysis.* The problem of theoretically analyzing the growth of profiled crystals is a problem of (first) finding the relationship between the structure of the shaper and the shape of the column of melt, (second) stabilizing the crystallization process, and (third) finding the crystallization conditions required to produce crystals with desired physical properties.

A problem of capillary shape formation has been formulated in a general way to solve the first of these problems.[2-5] It has been shown that the role of the shaper reduces to one of either engaging the column of melt beyond the edges or fixing the angle between the melt and the walls of the shaper. These two distinct regimes mandate two types of boundary conditions for the capillary Laplace equation, which describes the surface shape of the column of melt. The solution of boundary-value problems formulated in this manner will make it possible to find the relationship between the shape of the column of melt and the design of the shaper.[2-5]

The stability of the crystallization process has been studied[6,7] by the Lyapunov method.[5,8] A system of Lyapunov equations has been derived explicitly through the use of the heat-conduction equations for the crystal-melt system, the Navier-Stokes equation, and other fundamental relations. Analysis of the stability of this system has revealed the crystallization schemes and regimes in which the crystallization process is stable, i.e., in which a crystal of constant cross section can be synthesized. It turns out that this method for studying the stability also applies to other crystallization methods which use capillary shaping: the Czochralski, Verneuil, Kyropuulos, and zone-melting methods.[9-13]

The solution of the third problem requires a study of the hydrodynamics of the melt and the temperature distribution in the growing crystal for the purpose of determining the required distribution coefficients of the dopants and for reducing the thermal stresses in the crystal.[14]

2. *Experiments on the growth of profiled crystals.* Some materials of technological importance are used to grow profile crystals: sapphire, silicon, and lithium niobate.

Sapphire is grown in the form of plates, tubes, and other closed profiles of more complicated shape. The primary defects which must be avoided during the growth are individual pores and aggregations, block boundaries, and second-phase inclusions. The primary fields of application are in the substrates for silicon-on-sapphire structures and the envelopes of high-pressure sodium vapor lamps, intense light sources, etc.

In the case of sapphire a variational shaping method has been developed, which makes it possible to change the cross section of the sample during the growth. Sapphire crucibles have been fabricated by this method.

Silicon is also grown in the form of plates, tubes, and other closed profiles. The primary effects to be avoided in this case are block boundaries, twinning boundaries, and inclusions of silicon carbide. The most important fields of application are in solar energy convertors, the elements of technological equipment in electronics in place of the quartz which is presently used.[16,17]

Lithium niobate is grown in tapes. The basic defects which must be avoided during the growth are pore clusters and a polydomain structure. The primary fields of application are in surface-acoustic-wave electronic devices and piezoacoustic transducers.[18]

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