MODELING OF HEAT AND MASS TRANSFER AT GROWTH OF LARGE SIZE BGO CRYSTALS

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To date the developed technologies of bismuth germanate (BGO) crystal growth ensure production of several tens of tons crystals per year. Increase of crystal size without additional spends for expensive platinum crucibles and other equipment provides decrease of production cost.

The ratio between crystal and crucible diameters in conventional Czochralski method does not exceed 0.6. It is caused by difficulties in maintaining steady crystallization conditions at crystal/melt interface (CMI). This is connected with low melt thermal conductivity and bad heat removal leading to CMI shape changes and capture of inclusions. In particular, for BGO the lower defect ingot part formed by spiral inclusions increases with crystal diameter [1].

Numerical modeling of global heat- and mass transfer using the CGSim software [2] has been applied for determination of optimal growth conditions for BGO crystals of 80 mm dia. in crucibles of 96 mm dia. The main task was to evaluate the conditions of CMI convexity decrease for crystal defect part minimization. Boundary conditions for simulation (temperature distribution at melt surface before seeding, and melt temperature near crucible wall during crystal growing) were determined experimentally by IR pyrometer. The optimal crystallizer geometry with additional bottom heater installed under the crucible has been determined, as well as parameters allowing one to minimize the ingot defect part has been evaluated.

Thus, numerical modeling assures crystal diameter increase and BGO production cost minimization without expensive and long-term growth experiments.

References

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[2] http://www.semitech.us/products/cz_growth_simulator/