1. Introduction

The improvement of the optical and laser single crystals production technology from the melt of leucosapphire and yttria-allumina garnet (YAG) largely determines the success of the most important directions in the development of microelectronics, energy, optoelectronic and laser technology. The range of positive properties of sapphire monocrystalline is very wide - generation, amplification and transmission of electromagnetic waves. Such widespread use of single crystal sapphires is possible due to their unique properties - high optical uniformity and clarity in a wide range of light wavelengths, radiation resistance and also high mechanical, thermal and dielectric properties [1 - 2].

Large demand for bulk of sapphire optical products, which are widely used as illuminators, optical windows in aviation and aeronautics etc., generates the inquiry of effective production of high quality industrial crystals.

2. Horizontal crystallization method

Especially for these products the horizontal single crystal sapphire crystallization method is suitable - the so called Bagdasarov method (Fig. 1).

Without encompassment of the production technology of this special container made from thin molybdenum sheet it is not realistic to consider the productive exploitation of horizontal crystallization systems in engineering practice. The optimal shape and geometry will provide safe growth of sapphire single crystal (Fig. 2).

The technology of crystal growth is based on putting the crystal seed into the front of the crucible. The crucible is slowly moving in the vacuum passing the heating area, then the melting area and finishing in the cooling (crystallization) area. This method allows to create relatively large single crystals with relatively high velocity of grow (8-10 mm per hour) with precise shapes in more crystallographic directions [4].

The success of the described method depends on the shape of the molybdenum crucible, its adhesion to single crystal surface and its fast and repeatable production.
3. Molybdenum sheet properties

The production of the molybdenum sheet is difficult. The quality of the molybdenum sheets varies in a wide range— they are very fragile and cold-short. It is demonstrated almost in every first draw, where the micro cracks are observable. The second draw increases the cracks created in the first draw. Thus, it is very difficult to draw the drawn part up to the height equal to the diameter of the part (55% of the overall reduction of the blank area).

The cracks appear always if the deformed sheet is wrinkled after the first draw. When the second draw is applied, the waves are getting straight and the sheet bent in the opposite direction cracks. According to this fact, the sheet blank has to be held all the time of the drawing process [5 - 6].

The draw beads and lock beads mean that the material flow can be controlled, fine-tuned by FEM simulation and ultimately the toolmaker’s experience, so that the defects of cracking, over-reduction of sheet thickness and wrinkling can be avoided.

Instead of the blank holder and the draw and lock beads, the forming die radius is also very important. If the radius is too small, the sheet gets cracked. If the radius is too large, the blank gets wrinkled at the edge [7]. The choice of the radius value influences not just the bead dimension, but also the drawing material.

4. Baosteel/Sanchez experiment principle

To obtain the right blank holder force and the die edge curvature, the Baosteel/Sanchez experiment was done. The test device developed for this experiment allows changing the die edge radii and simulating various blank holder forces, which causes the change of the draw beads versus blank friction coefficient [8].

Figure 3 shows the principle of the experiment. The sheet metal strip with the thickness $c$ is drawn through the bunch of rotating guiding cylinders (rotation friction is omitted) with the drawing force (DBRF) and the couple of nonrotating bending cylinders and one holder cylinder held down to the moving strip with the holding force (HDF). The radii of the holder and bending cylinders $R, r_1, r_2$ are variable. The value of the holding force HDF depends on the depth of the holder cylinder push $H$ [9].

5. Test device structure

The experimental device was designed according to the principle of the Baosteel/Sanchez experiment [10]. The 3D model of the developed device is shown in Fig. 4. It can be mounted to the test machine LabTest 5.20ST (Fig. 5). The test device allows to:

- test molybdenum strips of 0.5 - 1mm thickness;
To prevent the oxidation of the molybdenum sheet, inert gas (Argon) can be put into the test device. The gas is put to the test device chamber by small overpressure, which causes the air crowding-out [17].

The temperature will be measured on the top and bottom part of the molybdenum sheet by a pair of thermocouples [18].

7. Conclusion

The test procedures on the presented test device can be done up to the temperature of 400°C. The research procedures available using the presented test device can be described as follows:
- research of the press offset depth and holding force dependence,
- the influence of the temperature increase and the inert gas atmosphere to the deformation process,
- the friction coefficient change between the molybdenum sheet and the holder cylinder by the holder cylinder lubrication,
- verification of the suitability of the holder cylinder material and hardness.

Acknowledgement

This paper presents results of work supported by the Slovak Scientific Grant Agency of the Slovak Republic under the project No. VEGA 1/0077/15.
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