Description

Sapphire (α-Al₂O₃) is characterized by high optical transparency, wear-, heat-, chemical resistance, high heat conduction and unique dielectric characteristics. Such combination of properties makes it an indispensable material for making highly integral microcircuits, input windows of semiconductor and electrical vacuum devices, technological lasers, optical devices operating under extreme conditions. The fields of sapphire application are constantly broadened. A technology is proposed for the growing of high optical quality sapphire single crystals 215x215x30 mm by the horizontal oriented crystallization (HOC) in protective gas medium. The proposed technology is directed toward using a low-pressure, protective gas medium in the dynamic pumping regime. Besides other advantages, this makes possible a partial substitution of metallic heating equipment using cheaper carbon.

Innovative Aspect and Main Advantages

One of the main advantages of this technology – a possibility to use cheap raw material with a higher concentration of impurities. Due to intensive evaporation from the melt during melt crystallization (the ratio of the melt area to its volume (S/V), the impurities level is the biggest in the HOC method, as compared to other technologies. Additionally, the development of this method was followed by the replacement of high vacuum by the CO gas atmosphere, which allowed to make HOC method one of the most efficient one for growing extremely large sapphire crystals with (0001) orientation. Main characteristics of the crystals:

- transparency in the UV-region: > 70%;
- uniformity of optical characteristics in the UV-region: <10%;
- twins, blocks and regions with high stresses are absent;
- the chemical purity of the material: 99.99%.

Areas of Application

Sapphire single crystals of a large size are of interest for many industries, but the best suited for optics and optoelectronics. The performed marketing investigations show that the large-size sapphire crystals are promising for application of this material in:

- in large-size (50… 220 mm) optics (transparent windows, screens, glasses) for working under extreme conditions and possessing long-term service life;
- in a field of optoelectronics, such as (0001)-oriented substrates for light-emitting diodes (LED’s); extremely bright screens with a diameter of 3”-4”; electroluminescent sources of light, etc.

Stage of Development

The experimental equipment and several batches of samples are available. A business-plan for organization of pilot production of sapphire crystals at the STC “Institute for Single Crystals” on the basis of the new generation installations “Horizont-2” is developed.

Nowadays the output of the pilot plant is 5000 kg of sapphire single crystals per year.

A wide variety of large size sapphire articles (50...220mm in diameter) for optics and optoelectronics is produced and delivered to USA, France, Germany, Israel, Taiwan etc.

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