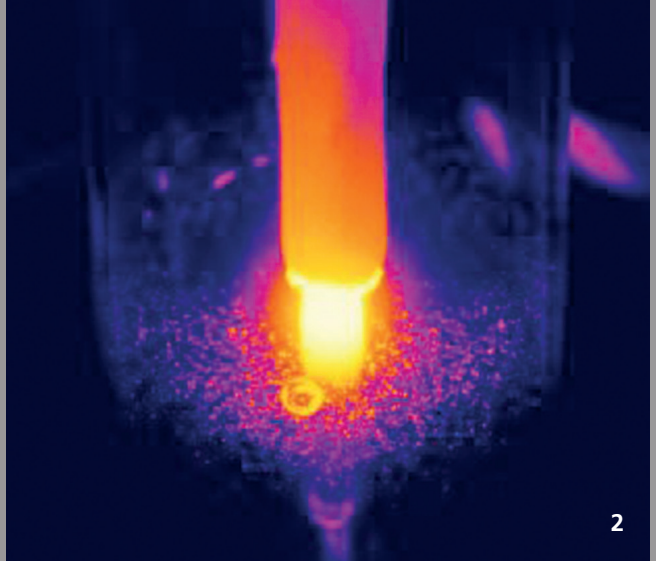
1



2

DEVELOPMENT OF AN OPTICAL SYSTEM FOR GROWING β-GA_2O_3 SINGLE CRYSTALS

Task

β-Ga_2O_3 is a wide bandgap semiconductor characterized by a particularly large bandgap of about 4.8 eV. Compared to SiC or GaN, β-Ga_2O_3 single crystals can be grown comparatively efficiently and economically due to their low melting point of about 1800 °C. Currently, mainly crucible-based processes such as the Czochralski method are used for this purpose. However, the purity of the crystals achievable is limited by melt contamination owing to diffusion of crucible material. By applying the crucible-free, laser-diode-heated floating zone (LDFZ) method, the Japanese National Institute of Advanced Industrial Science and Technology (AIST) has been able to efficiently grow high purity Ga_2O_3 crystals. In a joint project with AIST, Fraunhofer ILT is continuing to develop the LDFZ method and to grow crystals with a diameter of up to 51 mm.

Method

In the LDFZ method, the generally polycrystalline starting material is irradiated radially with laser diodes and melted in a defined area. For this purpose, Fraunhofer ILT is developing and setting up an optical system, with a fiber-coupled diode laser used as the beam source. So that a process-adapted intensity distribution can be generated, the radiation emerging from the fiber is homogenized and split into five beams of equal power, which are finally guided radially to the processing point via deflecting mirrors.

Results

The diameter of the crystals grown at AIST using the LDFZ method was increased during the project from 8 mm to currently 12.7 mm. In addition, Fraunhofer ILT has developed an optical system which can be used to grow crystals with a diameter of 38 mm and 51 mm. The optical system will be set up at Fraunhofer ILT in 2020 and operated in combination with a diode laser having a maximum optical output power of 20 kW.

Applications

Currently, the industry is investigating Ga_2O_3 crystals and other metal oxides grown using the LDFZ method and their suitability for applications in high-performance electronics.

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1 Optical setup for the crystal growing system.

2 Temperature profile on the Ga_2O_3 crystal during the growth process.