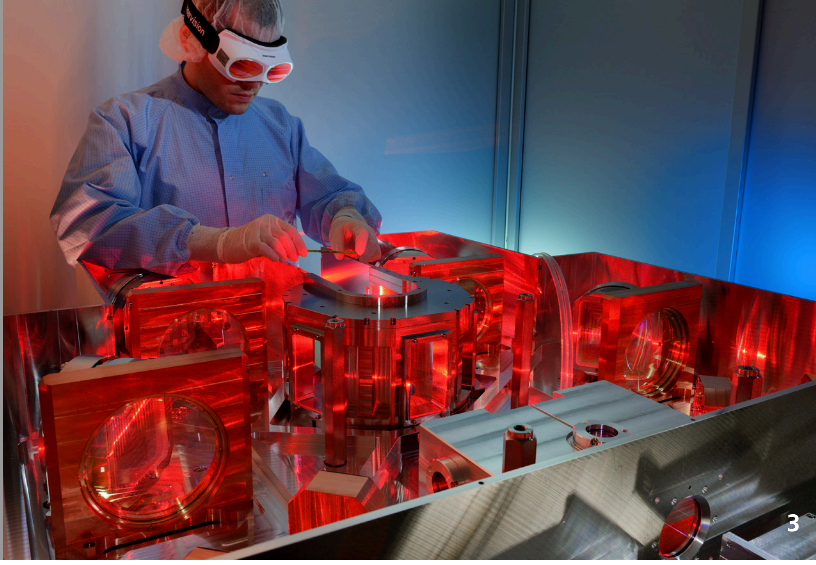

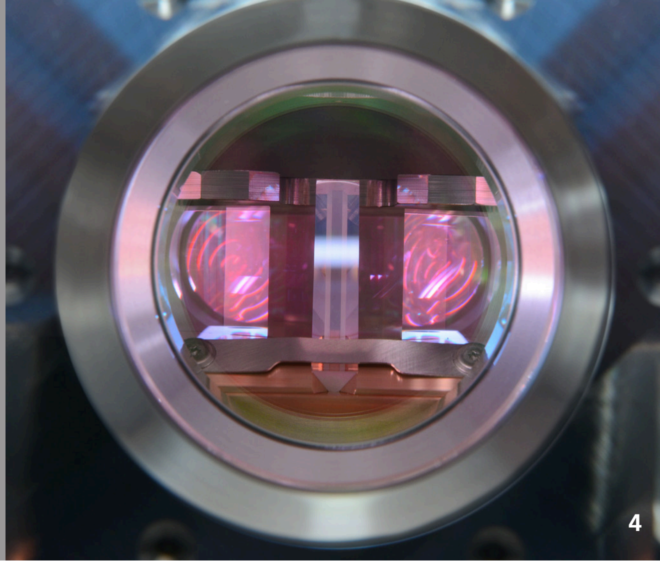

LASER FLOATING ZONE SYSTEM FOR THE GROWTH OF β–GA_2O_3 SINGLE CRYSTALS

Task

Among semiconductors, β-Ga_2O_3 stands out since it has a comparatively large bandgap of approx. 4.8 eV, which predestines the material for use in high-performance electronics. In addition, Ga_2O_3 can be grown in monocrystalline form from the molten phase, in contrast to the established wide bandgap semiconductors SiC and GaN. For β-Ga_2O_3, the crucible-free floating zone method can be used; here the material is melted in a defined area with diode laser radiation (LDFZ method). Together with the Japanese National Institute of Advanced Industrial Science and Technology (AIST) and the Chair for Laser Technology LLT, Fraunhofer ILT has continued to develop the LDFZ method, scaling up the system performance into the multi-kilowatt range and increasing the crystal diameter to 1.5 to 2 inches.

Method

Using preliminary tests at AIST in the field of LDFZ crystal growth, Fraunhofer ILT developed, set up and put into operation an optical system for shaping multi-kW diode laser radiation. A fiber-coupled diode laser was used as the beam source. In addition, the institute developed, built and tested a switch box to evaluate temperature, leakage and flow sensors as well as to control the laser interlock. At AIST, the laser, the optics system and the read-out electronics were integrated into the existing crystal growing furnace and the entire system was put into operation.

Results

To generate a process-adapted intensity distribution, the laser radiation emerging from the fiber is homogenized and divided into five partial beams of equal power, which are finally guided radially to the processing point via deflection mirrors. The optical system was characterized by measuring the intensity profiles for the individual partial beams at 150 W. In addition, an endurance test with a power of 20 kW was successfully carried out. After commissioning the system, AIST conducted the first melting experiments with polycrystalline Ga_2O_3 feed rods with a diameter of 1.5 inches.

Applications

Currently, the LDFZ method is used to grow Ga_2O_3 crystals as well as other metal oxides whose suitability for applications in high-performance electronics is being investigated. In addition, the suitability of this method is being examined for other crystal materials.

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3 Setup and commissioning of the LDFZ optical system.

4 View of the beam splitter unit through the entrance window.