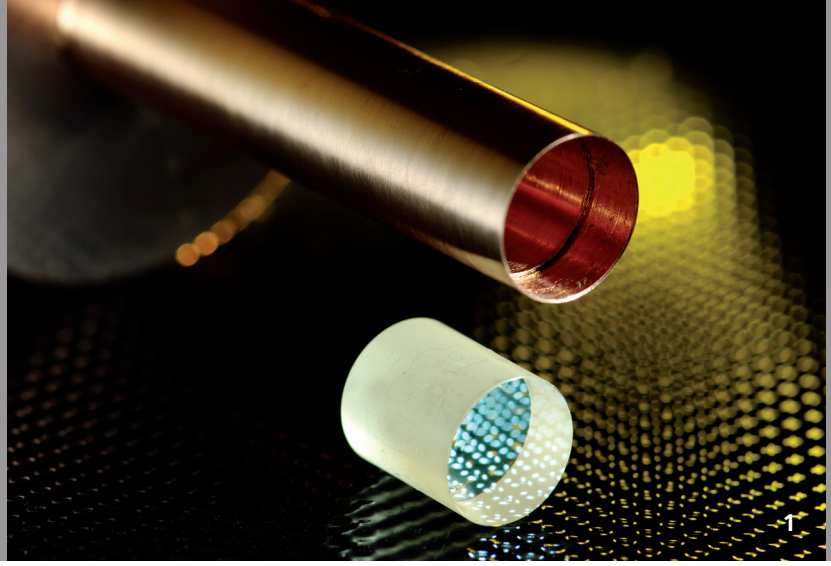

FARADAY ISOLATOR FOR HIGH-POWER FIBER LASERS

Task

Fiber lasers have become a standard tool for the industrial processing of sheet and powdered metals. During processing, the dynamics within the weld pool or an unfavorable positioning of the beam path may cause the laser beam to be back-reflected into the beam source. Since fiber lasers are by their very nature sensitive to back-reflections, there is a need for optical isolators to prevent the reflected radiation from being recoupled into the source and to ensure stable, fault-free operation of the laser. This setup paves the way for additional applications and enables processes that have always suffered from back-reflection problems to be implemented reliably with laser output powers in the kW region.

Method

In order to maintain the excellent beam quality of the fiber laser, an initial stage investigated improved Faraday rotator crystals made from terbium gallium garnet (TGG) with extremely low absorption. The crystals were exposed to a laser beam with up to 1 kW of output power and a beam parameter product of 3 mm x mrad, and both the beam quality and the signal polarization behind the crystal were measured as a function of the transmitted power.

1 Cylindrical TGG crystal for the Faraday rotation (length: 11 mm, Ø 10 mm).

Result

The project partner further optimized the absorption characteristics of the crystals so that operation was possible with 1 kW fiber laser radiation with a beam parameter product of 3 mm x mrad without any measurable degradation of the beam quality. The degree of polarization of the transmitted radiation decreases from 17 dB with no TGG crystal (reference measurement) to 16 dB with a TGG crystal, which is attributable to thermally induced effects, especially stress-induced birefringence. The influence of the thermally induced lens is minimal and can, if necessary, be compensated by adding an appropriate aspherical lens to the setup. The Faraday rotator thus meets the requirements for laser material processing.
On this basis, an isolator for average output powers of 1 kW is currently being implemented, and will subsequently be tested in an industrial environment.

Applications

Wherever material is processed using fiber lasers, especially for applications in the high-power segment such as cutting, welding or selective laser melting, an isolator can be used in order to stabilize the process while protecting the beam source from damage. The usability of such a device can be increased further by means of double-sided fiber coupling. This research was funded by Germany's Federal Ministry of Education and Research (BMBF) under reference code 13N9890.

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