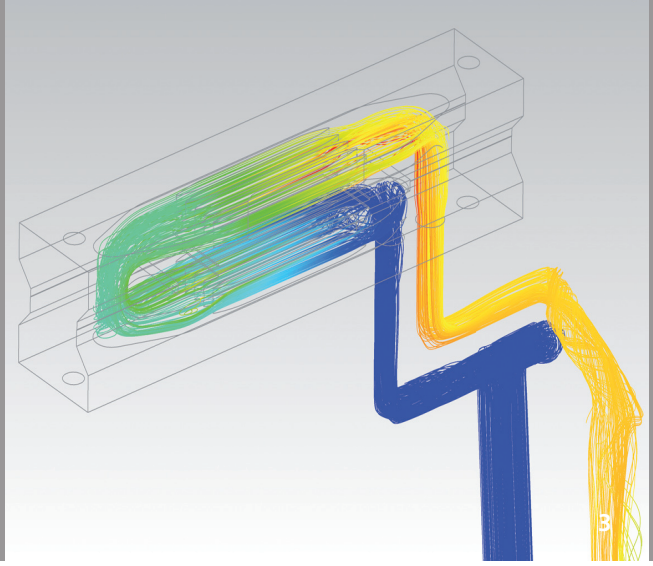

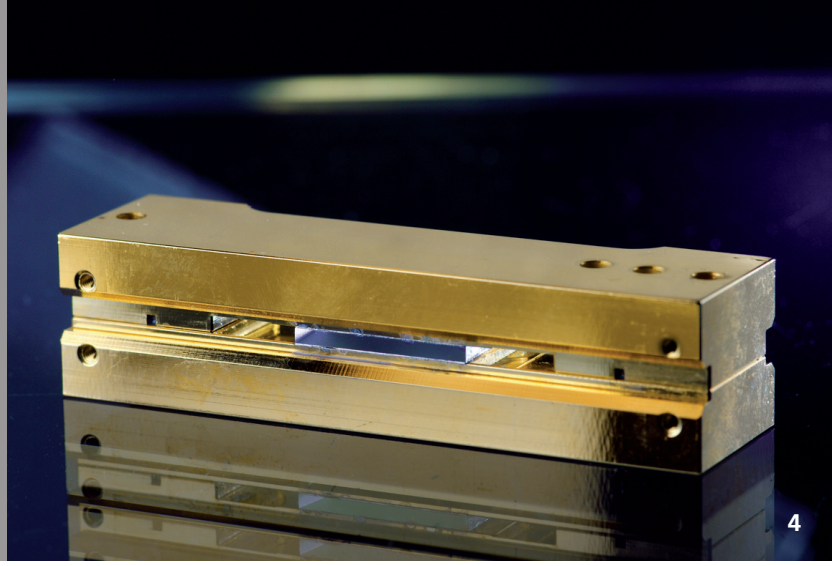

REFLOW SOLDERING PROCESS FOR LASER CRYSTALS

Task

Laser crystals constitute the key component of any solid-state laser. A reliable, good thermo-conductive connection between crystal and heat sink is therefore crucial in meeting the increasing requirements in relation to beam quality, pump and output power, thermal stability and robustness. To improve the thermal performance and long-term stability, in particular, reflow soldering is replacing clamping and adhesive techniques. The process needs to be suitable for various types of crystal.

Method

Actively or passively cooled heat sinks are used, taking into account the properties of the crystal materials such as Yttrium Aluminum Garnet (e.g. Nd:YAG or Yb:YAG) or Yttrium Vanadate (e.g. Nd:YVO_4), and optimized in relation to homogeneous cooling with low thermal resistance. The reflow soldering process developed at Fraunhofer ILT generates the thermal interface between the crystal and metallic joining partner. The process chain, consisting of solder application, metallization of the components and soldering process is coordinated and defined depending on the specific task.

Result

A fluxing-agent-free soldering process was developed for assembling rectangular crystals (= slab) in particular. The results were applied to various crystal geometries and applications. Thus reliable connections with high thermoconductivity were generated. Mechanical distortion of the laser crystals is also prevented. In temperature cycle tests the reliability of the connection was demonstrated in a range of -30 °C to +50 °C. With the Yb:YAG laser crystals measuring 10 x 10 x 1 mm^3 that were cooled in this way, an average laser output power of more than 700 W was achieved. Areas measuring 10 x 10 mm^2 are used as the cooling interface.

Applications

Laser crystal modules produced using the reflow soldering process are used in laser oscillators and amplifiers for solid state lasers, i.e. both for high-output ultrafast lasers and in LIDAR beam sources for aerospace applications. Expertise in fluxing-agent-free, low-tension and robust soldering technology can also be used to join other thermally and mechanically loaded components.

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3 Cooling circuit in the laser crystal module.

4 Soldered laser crystal module.