



## SOLDERING PROCESS DEVELOPMENT FOR CONTACTING CRYSTALS AND HEAT SINKS

### Task

Ytterbium INNOSLAB crystals must be cooled in amplifier stages of ultrashort pulse beam sources due to thermal stress. They are normally cooled by contacting them with active heat sinks. Here, homogeneous and pore-free bonding with high thermal conductivity is essential so that a slab crystal package can be used in high-power lasers. Fraunhofer ILT has analyzed and continued to develop the current reflow soldering process to improve reproducibility and reliability as well as to generate an optimized interface between crystal and heat sink. The institute has also taken the scaling of the transverse dimensions into account.

### Method

First, Fraunhofer ILT investigated the mechanical contact between crystal and heat sink after a reflow soldering process using computer tomography. Furthermore, it used a polarimeter to evaluate how the optical properties of the crystal changed due to the reflow soldering process. These changes include, in particular, the depolarization and the optical path difference. The results obtained here can be matched with parameters of the reflow soldering process as well as the specifications of the heat sinks and the crystal.

### Results

The contacts made with previous reflow soldering processes have individual pores which are large in proportion to the soldering area. These defects can also be detected by means of polarimeter measurements. In addition, hundreds of pores that are small in relation to the solder area can also occur in the solder joint. These small inhomogeneities, however, cannot be detected with polarimeters. The institute was able to significantly increase the homogeneity of the bond by adjusting the parameters of the reflow soldering process as well as the specifications of the heat sinks and the crystal. These solder layers exhibit few or no pores in the resolution range of the CT device used. Thus, the institute can demonstrate that the prerequisites for manufacturing optimized slab crystal packages for high-power lasers have been fulfilled.

### Applications

Based on the advanced soldering process, slab crystal packages for use in amplifier stages with about 5 kW pump power were built and experimentally investigated.

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1 Slab crystal package.