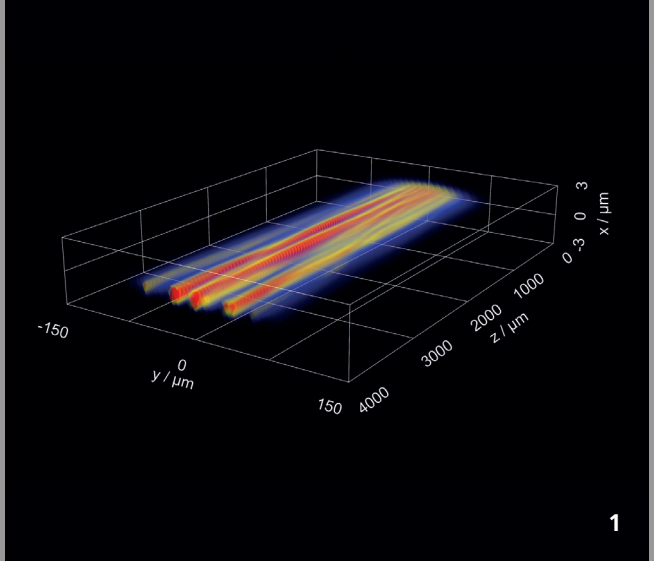
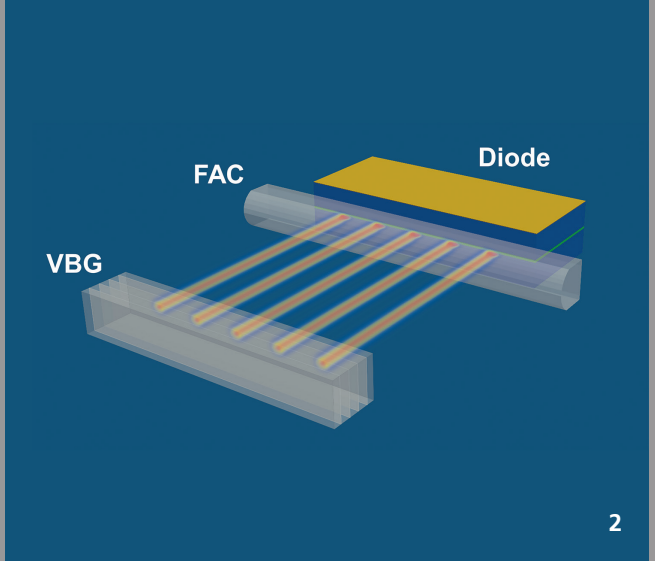


1



2

MULTIPHYSICAL MODELING OF HIGH-POWER LASER DIODES

Task

High-power laser diodes have the highest electro-optical efficiencies of all laser beam sources. Depending on the emission wavelength and operating point, they reach efficiencies of up to 70 percent. The degradation in beam quality at high output powers and the sensitivity to reflected radiation, however, currently hinder the use of direct diode laser systems in applications requiring high brilliance, such as laser remote welding. The sensitivity of the laser diodes to back reflection results in operating points below the maximum possible power.

Method

The »SEMSIS« software developed at the Fraunhofer ILT can be used to calculate the propagation of the optical field within the diode structure, the distribution of the electrical current density and the injected charge carriers, as well as the resulting optical amplification. The thermal model also takes into account the heating of the diode due to electrical losses and optical absorption. External resonators with elements for spectral stabilization are described by a wave-optical model. Finally, a defect model serves to describe the aging processes within the diode.

Results

By considering the complex interaction processes within the diode emitter, Fraunhofer ILT can model the reduction of the beam quality at high powers. Figure 1 shows this on the basis of the filamented optical field within an emitter. In addition, the institute can investigate the effects of external optical feedback on beam quality and damage mechanisms.

Applications

The software makes it possible to predictively design novel semiconductor structures and external optical resonators optimized for beam quality and lifetime. This allows users to selectively optimize the diode design so that costly and time-consuming parameter studies on real diodes can be reduced significantly.

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1 Optical field within a laser diode.

2 Optical feedback in external resonators.

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