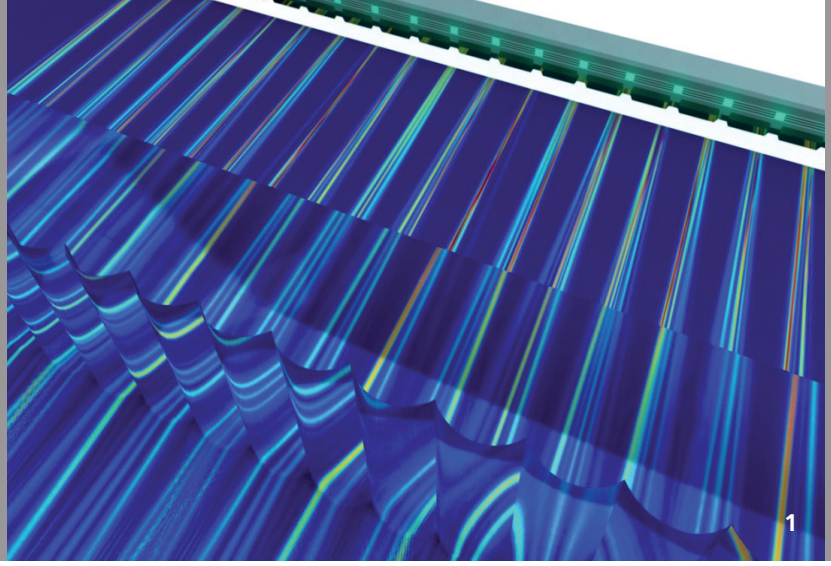

SIMULATION OF HIGH-POWER DIODE LASERS

Task

When high-power diode lasers are used for coherent or incoherent beam superposition and for pumping solid-state lasers, the requirements upon them are high power and spectral stability for line widths of < 1 nm. Non-linear effects, such as the thermal refraction index variations and refractive index variations induced by charge carriers, lead to filamentation of the light field. By frequency-selective external optical back coupling, the spectral width of the emitted radiation is reduced and the shifting of the centroid wavelength, dependent upon operating point, is reduced. The specific values of the spectral stabilization are determined according to the state-of-the-art in the experiment.

Method

The goal is to develop models to calculate the dynamics of the electromagnetic field in diode laser edge emitters with coupled frequency-selective external resonators. To simulate diode laser edge emitters and micro-optics, such as volume Bragg gratings and aspherical collimation lenses, software solutions have been developed, whose use enables the analysis of innovative micro-cavity lasers with external resonators for longitudinal or transversal mode selection.

Result

The laser model calculates spatial and spectral distributions of the field parameters, radiation characteristics, including near and far-field distributions of the astigmatic laser radiation, emission spectrums and the optical output power dependent upon the operating current. The wavelength is stabilized by an external spectral filter, which can be simulated numerically. The underlying semiconductor theory serves to determine amplification, refraction index variations as well as spontaneous emission dependent upon frequency, local temperature, charge carrier- and photon density. The stabilization range and the optical output power have been calculated in dependence upon facet reflectivity, thermal resistance and back coupling efficiency of the external optical system.

Applications

The results of the numerical analyses deliver dimensioning criteria and parameters for the design of optical systems for high-power diode lasers while the relevant properties of semiconductor structure and material are taken into consideration.

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1 Diode laser bars: simulation of lateral field distribution.