The stabilization of the laser beam in a BA laser can be achieved, for example, by injection of the optical beam at some angle to the longitudinal axis or by the external optical feedback from the corresponding off-axis mirror or grating. An introduction of 1d or 2d-periodic structures on the electrical contact can also help to improve the quality of the generated beam in BA lasers or of the amplified beam in BA amplifiers. In this talk some of these schemes allowing an improvement of the beam quality in the BA devices will be discussed. Our theoretical study is based on the simulations of the 2+1-dimensional traveling wave model which takes into account the spatio-temporal dynamics of slowly varying complex amplitudes of the counter-propagating optical fields, induced polarizations and carrier densities. A proper resolution of the fast oscillating fields, as well as the resolution of a sufficiently large optical frequency range, requires a fine space (up to 10^6 mesh points) and time (up to 10^6 points for typical 5ns transient) discretization. The resulting large numerical scheme is solved using multilevel parallel distributed computing, that allows us to run long time dynamic simulations over large parameter ranges in reasonable time. Comparable computations on a single PC system take nearly 100 times longer.

Laser array phase-locking and nonlinearity

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The talk will discuss a situation where nonlinearity plays a key role in the behavior and in the dynamics of coupled lasers. Focusing on fiber lasers, Kerr nonlinearity and resonant contribution from the gain will be compared. In the context of coherently coupled fiber laser array, specific resonator and specific filtering can be implemented to compensate for path length differences in the laser array by nonlinear contribution. Theoretical results, as well as preliminary experimental results, will be reported showing improvement in the phase-locking of fiber laser array through resonant nonlinearity.

Control of optical switchings in a bistable vertical-cavity surface-emitting laser by vibrational resonance

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We present experimental results which demonstrate that the response of a bistable laser at a selected polarization to the effect of the periodically modulated optical feedback or injection at the orthogonal polarization can be considerably enhanced by the additional periodic current modulation through the phenomenon of

vibrational resonance. At the optimal amplitude of the current modulation a complete synchronization of optical switchings between polarization states with modulated optical signal is observed which can be in-phase or anti-phase with respect to the optical signal. The effect of a delay of the response of the bistable laser with respect to the modulating optical signal is found out which can be controlled by the current modulation. The influence of the asymmetry of a bistable quasi-potential on the efficiency of optical switching is experimentally demonstrated. These results can be important for enhancement of sensitivity of sensors based on a bistable laser as well as for development of optical switches for optical communication systems, controlled through the current modulation.

The possibility of using distributed space-time models for simulation of various operational modes of solid-state laser

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On an example of solid-state diode-pumped lasers it has been demonstrated the necessity to use spatially distributed laser model for simulation of various modes of operation (e.g., cw, Q-switch, Q-switched mode-lock) for such lasers. Simulation of such system's pecularities as nonuniformity of the pump, existence of saturable absorber elements as well as large time delay feedback are also discussed.

Theoretical investigation of hybrid mode-locking in two-section semiconductor quantum dot lasers

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In the present work theoretical investigations of hybrid mode-locking in semiconductor quantum dot lasers were carried out using a mode-locking model based on a set of 3 delay-differential equations. The reverse bias modulation was described by a periodic variation of the carrier relaxation rate in the absorber section. Dependence of the locking range on the modulation amplitude and modulation shape has been studied numerically and analytically using asymptotic analysis. It has been shown that in the case of pulsed modulation shape locking range is asymmetric with respect to the frequency of passively mode-locked laser. This asymmetry is related to the dependence of the pulse repetition frequency on the modulation amplitude. Finally it has been demonstrated that the hybrid mode-locking regime can be achieved in the case when the modulation frequency is approximately twice higher or lower than the pulse repetition rate of the free running passively mode-locked laser.