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Regulation and control of random fiber lasers

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The idea of making random lasers in one dimensional optical structures, such as optical fibers, has arisen great interests in the research world, because that the waveguide function provided by optical fibers help to reduce lasing threshold as well as to enhance emission directionality. Random distributed feedback fiber laser (RDF-FL) is a novel type of random laser reported by *Turistsyn et al*. based on a roll of single-mode fiber (SMF) in 2010. The SMF itself performs as the disorder medium, where Rayleigh backscattered (RS) radiation captured by fiber waveguide provides distributed feedback while the Raman pump provides optical amplification for generation of random lasing (RL). Compared with traditional random lasers, the RDF-FL shows relative stable output, single-transverse-mode profile, long-distance emission and wide wavelength tunability, which are of great interest in optical communication and optical sensing. To tune output wavelength of RDF-FLs, a passive component, i.e., a Fabry-Perot cavity combined with a LPFG based MZ interferometer, was designed to selectively feedback RS of a RDF-FL, and a novel all-fiber tunable multi-wavelength Raman fiber laser is achieved by us. To reduce the lasing threshold and design the output characteristics, a high nonlinear fiber, i.e., dispersion compensated fiber (DCF), with relative high Raman gain factor and RS was proposed to make RDF-FLs. Through combinations of SMF and DCF of varying length, the length and the lasing threshold of RDF-FL can be reduced remarkably when DCF is inserted at some position in the lasing cavity. Moreover, power distribution and spectrum of RDF-FL can be designed by controlling the length and the position of the DCF. Besides Raman gain, it is also possible to provide gain through active fibers, such as Er-doped fiber (EDF). In our studies, single-peak random lasing can be realized in a completely-opened cavity through pumping of both the EDF and the SMF. Combination of EDF and Raman amplifications helps to reduce the requirement of a unique pump for stable random lasing, as well as to reduce (increase) the threshold (output) power of RDF-FL. What's more, random lasing with novel output characteristics, (i.e., stable single-peak random lasing and transitional variation between chaotic and stable states) are observed. In EDF, random distributed feedback can also be provided by inscription of randomly separated fiber Bragg gratings (FBGs), which usually generate unstable RL modes competition. In our case, a laterally-injected control light is used to induce local gain perturbation, providing additional seed light for certain random resonance modes. As a result, active mode selection of this type of RDF-FL is realized by changing locations of the laser cavity that is exposed to the control light.

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Optical properties of quantum cones formed in semiconductors by laser radiation

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Nowadays, nanostructures are one of the most investigated objects in semiconductor physics, especially due to Quantum confinement effect (QCE) in quantum dots (0D), quantum wires (1D) and quantum wells (2D). A new laser technology elaborated for quantum cones formation in semiconductors is reported. A cone possesses the following unique properties: A small cone is a quantum dot – 0D and a long one is a quantum wire – 1D with the gradually decreasing diameter from the base till the top of the cone. Such quantum cone luminesces like rainbow. Quantum cones on the surface of elementary semiconductors Si and Ge single crystals, and on a surface of SiGe and CdZnTe solid solutions were formed by fundamental frequency and second harmonic of Nd:YAG laser radiation. Strong change of the optical properties of the semiconductors after irradiation by Nd:YAG laser are explained by the presence of QCE in quantum cones. "Blue shift" of photoluminescence spectra and "red shift" of phonon LO line in Raman spectrum are explained by exciton and phonon QCE in quantum cones, correspondently. Asymmetry of the photoluminescence band in the spectrum of Si quantum cones is explained by 1D graded band gap structure. Experimental data on quantum cones formation on a surface of Si, Ge and their solid solution and CdZnTe crystal and their optical properties are presented. Two-stage mechanism of quantum cones' formation on a surface of the semiconductors is proposed. The first stage of the mechanism is characterized by the formation of a thin strained top layer, due to redistribution of point defects in temperature-gradient field induced by laser radiation. The second stage is characterized by mechanical plastic deformation of the stained top layer leading to arising of quantum cones due to heating up of the top layer. Formed quantum cones can be applied for design of third generation solar cells, Si white light emitting diode, photon detector with selective or "bolometer" type spectral sensitivity and Si tip for field electron emitting with low work function.

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