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A NOVEL LASER TECHNOLOGY FOR NANOSTRUCTURE FORMATION IN SEMICONDUCTORS

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A novel laser technology elaborated for nanostructures formation in semiconductors is reported. Nanohills on the surface of Ge single crystal were formed by Nd:YAG laser radiation at intensity of 30.0MW/cm^2. In the case of Si and GaAs single crystals nanohills were formed by the second harmonics of Nd:YAG laser radiation at intensity of 2.0 MW/cm^2 and 5.5 MW/cm^2 correspondently. The same nanostructures were induced on the surface of Si_xGe_{1-x}/Si heterostructures with x = 0.3 and 0.4 by basic frequency of Nd:YAG laser radiation at intensities from 2.0 till 20.0MW/cm^2. Random distributed of nanohills were formed on the surface of $Cd_{1-x}Zn_xTe$ ternary compound with x = 0.1 by the second harmonics of Nd:YAG laser radiation at intensity within 4.0 – 12.0MW/cm^2. The mechanism of nanostructures' formation on the surface of semiconductors using Atomic force microscope, Electron scanning microscope, Photoluminescence (PL) and Raman back scattering methods was studied. Unusual photoluminescence spectrum from the irradiated surfaces was found in the visible range of spectrum. PL from Ge, SiO_2/Si, SiGe/Si and GaAs nanostructures can be explained by Quantum confinement effect. A shift of micro-Raman scattering spectra in Ge and GaAs is a good evidence of this suggestion. Asymmetric of PL spectra of the irradiated SiO_2/Si structure is explained by Quantum confinement effect in nanohills-nanowires with a graded decrease of diameter toward the top of nanohill. The mechanism of nanohills formation in $Si_{1-x}Ge_x$/Si structure by laser radiation is proposed. The "blue shift" of exciton band in PL spectra of the irradiated $Cd_{1-x}Zn_xTe$ ternary compound is explained by graded band gap formation in nanohills due to Exciton Quantum confinement effect. For the first time was shown the possibility of graded band gap structure formation in elementary semiconductors. Thermogradient effect has a main role in initial stage of nanostructures formation by laser radiation in semiconductors.