A NOVEL LASER TECHNOLOGY FOR NANOSTRUCTURE FORMATION IN ELEMENTARY SEMICONDUCTORS: QUANTUM CONFINEMENT EFFECT

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Nowadays, nanostructures are one of the most investigated objects in solid-state physics, especially Quantum confinement effect in quantum dots, quantum wires and quantum wells. In the case of nanosize structures the energy band diagram of semiconductor has strongly changed. This leads to a crucial change of semiconductor properties such as: electrical (due to the change of free charge carrier concentration and electrons' and holes' mobility); optical (absorption coefficient, reflectivity index, radiative recombination efficiency); mechanical and heating properties. It is known that in elementary indirect band-gap semiconductors such as Si and Ge radiative electron–hole recombination efficiency strongly enhances in nanostructures due to QCE [1]. Moreover, shift of Photoluminescence (PL) spectrum toward high energy of spectrum, so called "blue shift", has been predicted [1] and observed in Ge [2] and Si [3] single crystals.

A novel laser technology elaborated for nanostructures formation in elementary semiconductors is reported.

Nanohills on the surface of Ge single crystal were formed by basic frequency of Nd:YAG laser radiation at intensity of 30.0MW/cm^2 [4, 5]. This structure is characterized by patterns related to C_{6i} point group symmetry covering all the surface of the sample and having translations symmetry. In the case of Si single crystals nanohills were formed by the second harmonics of Nd:YAG laser radiation at intensity of 2.0 MW/cm^2 [6, 7]. 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 [8]. The mechanism of nanostructures' formation on the surface of elementary semiconductors was studied using Atomic force microscope, Electron scanning microscope, Ellipsometry, Photoluminescence and Raman back scattering spectra. Unusual photoluminescence spectrum from the irradiated surfaces was found in the visible range of spectrum. Photoluminescence from Ge, SiO_2/Si and SiGe/Si nanostructures can be explained by Quantum confinement effect. A shift of micro-Raman scattering spectra in Ge is a good evidence of this suggestion. Unique asymmetric photoluminescence spectra of the irradiated SiO_2/Si structure with gradually decrease intensity in read part of spectra is explained by Quantum confinement effect in nanohills-wires with a graded decrease of diameter toward the top of nanohill. The following mechanism of nanohills formation in $Si_{1-x}Ge_x$/Si structure by laser radiation is proposed: irradiation of SiGe/Si heterostructure by Nd:YAG laser initiates Ge atoms drift to the irradiated surface due to gradient of temperature - Thermogradient effect. After every laser pulse gradient of temperature increases due to increase

of Ge atoms concentration at the irradiated surface and new Ge phase formation occurs at the end of the process. Ge atoms are localized at the surface of Si like a thin film. Self-assembly growth of nanostructure on the irradiated surface takes place by Stransky- Krastanov' mode.

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 elementary semiconductors.

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ОБРАЗОВАНИЕ ТОЧЕЧНЫХ И НАНО-РАЗМЕРНЫХ ДЕФЕКТОВ ПРИ ДВИЖЕНИИ ДИСЛОКАЦИЙ В КРИСТАЛЛАХ ХАЛЬКОГЕНИДОВ КАДМИЯ

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Методами низкотемпературной фотолюминесценции (ФЛ) исследованы механизмы дефектообразования при движении и генерации дислокаций в кристаллах CdTe, $Cd_{1-x}Se_xTe$ (x<0.1 at. %), CdSe и CdS. При этом обнаружены три типа дефектов различной природы, которые проявляются в спектрах ФЛ.

1) Генерация дислокаций и их движение при макроскопической пластической деформации вызывает появление *совершенно новых* линий и полос излучения в спектрах ФЛ. Эти новые полосы не возникают при введения в кристалл традиционных дефектов решётки или примесей. Поэтому такое излучение получило название "дислокационного рекомбинационного излучения". Оно обычно состоит из нескольких серий узких линий, расположенных вблизи края фундаментального поглощения. Дефекты, ответственные за это излучение относятся непосредственно к электронным состояниям собственно ядра дислокации. Такая информация получена нами из сопоставления пространст-