AOMD-7

International Conference

ADVANCED OPTICAL MATERIALS AND DEVICES

ABSTRACTS

Vilnius
August 28-31, 2011

OPTICAL PROPERTIES OF NANOCONES FORMED ON A SURFACE OF ELEMENTARY SEMICONDUCTORS BY LASER RADIATION: QUANTUM CONFINEMENT EFFECT

A. Medvid', A. Mychko, and P. Onufrijevs

Research Laboratory of Semiconductor Physics, Riga Technical University, Riga, 14 Azenes Str.LV-1048, Latvia, e-mail: medvids@latnet.lv

On the basis of analysis of experimental results on elementary semiconductors such as, Si and Ge, and their SiGe and CdZnTe solid solution a two-stage mechanism of nanocones formation on the irradiated surface of semiconductors by Nd:YAG laser is proposed. Such properties are explained in the frame of Quantum confinement effect. The mechanism of nanocones' formation on the irradiated surface of $Si_{0.7}Ge_{0.3}$ solid solutions is characterized by two stages – Laser Redistribution of Atoms (LRA) and Selective Laser Annealing (SLA). The first stage of nanocones' growth - LRA is characterized by formation of top strained layer, enriched by Ge atoms in $Si_{0.7}Ge_{0.3}$ due to their drift to the irradiated surface in temperature gradient field induced by laser radiation. The main role in this process has Thermogradient effect. LRA is a nonlinear optical process: concentration of Ge atoms in the top layer of SiGe solid solution increase with number of laser pulses and at the same time absorption coefficient of the top layer increases. As a result, LRA stage gradually transits to SLA stage. The second stage of nanocones' formation on the irradiated surface of semiconductor – SLA – is selective laser absorption of the light by the top stained layer with further mechanical plastic deformation of the top layer due to relaxation of the mechanical compressive stress arising between these layers due to mismatch of their crystal lattices and heating of the top layer. SLA occurs due to higher absorption of the laser radiation by the top layer than the buried layer. A similar two-stages' model can be used for nanocones' formation by laser beam on ternary component solid solution $Cd_{0.9}Zn_{0.1}Te$. In the case of the elementary semiconductors, at the first stage of the process a thin top layer is formed by mechanical compressive stress due to separation of interstitials and vacancies in gradient temperature field on the irradiated surface of the semiconductors. At the second stage of the process nanocones are formed on the irradiated surface of the semiconductors due to plastic deformation of the top layer in the same way as in the previous case with semiconductor solid solutions. The model is confirmed by "blue shift" of photoluminescence spectrum, "red shift" of LO line in Raman back scattering spectrum of Ge crystal and non-monotonous dependence of Si crystal micro-hardness as function of the laser intensity.

Keywords: nanocones, quantum confinement effect, graded band gap structure, laser radiation, photoluminescence.