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MECHANISM OF NANOHILLS GROWTH IN $Si_{1-X}Ge_X$/Si STRUCTURE BY LASER RADIATION

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Abstract

This work is to study the mechanism of nanohills growth in $Si_{1-x}Ge_x$/Si structure by laser radiation. P-type Si (001), i-type Ge crystals and $Si_{0.7}Ge_{0.3}$/Si heteroepitaxial structure were irradiated by nanosecond Nd:YAG laser pulses.

Key words: *$Si_{1-x}Ge_x$/Si, Ge, SiO_2/Si, nanostructures, Thermogradient effect*

Semiconductor nanostructures have got considerable attention since they are building blocks of future nanoscale devices for electronics and photonics. Nowadays, nanostructures are the most investigated object in solid-state physics, especially concerning quantum confinement effect in quantum dots [1], quantum wires [2] and quantum wells. In the case of nanosize structures the energy band diagram of semiconductor is strongly changed. This leads to crucial change of the semiconductor properties such as: electroconductivity (due to the change of free charge carrier concentration and electrons and holes mobility); optical parameters (absorption coefficient, reflectivity index, radiative recombination efficiency); mechanical and heating properties.

The aim of this work is to study the mechanism of nanohills growth in $Si_{1-x}Ge_x$/Si structure by laser radiation. SiO_2/Si, i-type Ge crystals and $Si_{0.7}Ge_{0.3}$/Si heteroepitaxial structure were irradiated by nanosecond Nd:YAG laser pulses. Nanocrystals are grown on the irradiated surface of Si, Ge crystals $Si_{0.7}Ge_{0.3}$/Si and heteroepitaxial structure at intensity of the laser radiation up to 2MW/cm^2, 20MW/cm^2 and 25MW/cm^2, respectively. Self-organized structures are observed and characterized by AFM and Photoluminescence (Fig.1). The mechanism of nanohills growth in $Si_{1-x}Ge_x$/Si structure by laser radiation is proposed by following model: irradiation of SiGe/Si heterostructure by Nd:YAG laser initiates Ge atoms drift to the irradiated surface due to gradient of temperature - Thermogradient effect. This process is characterized by positive feedback: after every laser pulse gradient of temperature increases due to increase of Ge atoms concentration at the irradiated surface and new Ge phase formation at the end of the process. Ge atoms are localized at the surface

of Si like a thin film. Self-assembly of nanostructure on the irradiated surface takes place due to growth of nanostructure by Stransky- Krastanov' mode.

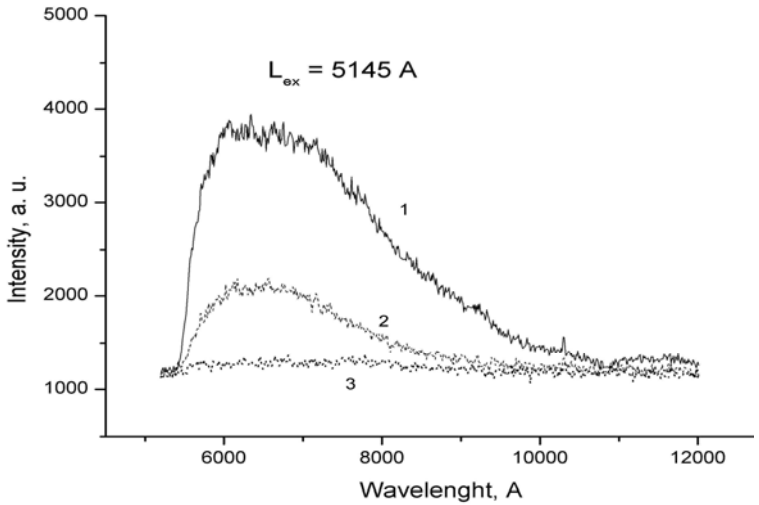

Fig.1.Photoluminescence spectra of the irradiated SiO_2/Si structure at intensity of the laser radiation up to 2.0 MW/cm^2 (curves 1 and 2), after removing of SiO_2 layer by chemical etching in HF acid (curve1) and PL of the non-irradiated surface (curve 3).

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