Nanocomposites and nanomaterials

Tin-induced crystallization of amorphous silicon by pulsed laser irradiation

A. Nikolenko[1], V. Strelchuk[1], B. Tsykaniuk[1], L. Fedorenko[1], P. Shepeliavyi[1], V. Melnyk[2], A. Kuzmich[3], M. Isaiev[3], I. Olkhovyk[2], and V. Neimash[2]

[1] *V. Lashkaryov Institute of Semiconductor Physics of NAS of Ukraine, 41 Nauky pr., 03028 Kyiv, Ukraine*
E-mail: Nikolenko_mail@ukr.net

[2] *Institute of Physics of NAS of Ukraine, 46 Nauky pr., 03028 Kyiv, Ukraine*.

[3] *Faculty of Physics, Taras Shevchenko National University of Kyiv, 60 Volodymyrska St., 01601 Kyiv, Ukraine*.

Composites of silicon nanocrystals (nc-Si) in a matrix of amorphous Si (a-Si) are considered as promising material for the next generation of cascade quantum-dot-based solar cells. A quasi-direct-gap absorption mechanism, of the band gap dependence on the size of nc-Si, and resistance to Staebler–Wronski effect make this material a cheap and environmentally friendly alternative to AIIIBV semiconductors. We report on controllable formation of nc-Si by a metal-induced crystallization (MIC) of a-Si in thin film a-Si-Sn structures under varied regimes of pulsed laser irradiation. Micro-Raman spectroscopy was applied to estimate a relation between amorphous and crystalline phases of Si, size and concentration of nc-Si in dependence on the power of laser pulses with duration of 10 ns and 150 μs and wavelength of 535 and 1070 nm. The threshold laser power initiating the MIT process is determined, and the role of photoionization in the formation and decomposition of the Si-Sn solution leading to the formation of nc-Si is evaluated. The possibility of an effective tin-induced transformation of a-Si into nc-Si phase during the irradiation time of 10 ns is demonstrated for the layer thickness of 200 nm. Theoretical analysis of spatial and time distributions of temperature within the laser-irradiated areas was performed. The estimated temperature corresponding to the onset of structural and phase modification was found to be close to Sn melting temperature, which confirms the MIC mechanism in eutectic layer at a Si–Sn interface consisting of cyclic repetition of the processes of formation and decay of the Si–Sn solution [1]. Considering the relatively high rate of the MIC process under pulsed laser irradiation, it has further prospects of application in the industrial technology of silicon thin film devices.

1. *V. Neimash et. al.* Tin induced crystallization in thin films of Si-Sn alloys // J. Appl. Phys. -2013.-**114**, -P. 213104.