17p-F2-1

Semiconducting alloyed silicon-tin nanocrystals synthesized via confined plasma used for quantum dot solar cells.

[1]Research Center for Photovoltaic Technologies, National Institute of Advanced Industrial Science and Technology (AIST), Central 2, Umezono 1-1-1, Tsukuba, 305-8568, JAPAN, [2]Nanotechnology and Advanced Materials Research Institute (NAMRI), University of Ulster, BT37 0QB, Northern Ireland, UK

○Vladimir Švrček[1], Mickaël Lozac'h[1], Davide Mariotti[2], Somak Mitra[2], Koji Matsubara[1],

E-mail: vladimir.svrcek@aist.go.jp

Nanocrystal solar cells that exploits new physical phenomena such as carrier multiplication (CM), present a great potential for substantial conversion efficiency improvement. In case of CM, when a photon hits a quantum nanocrystal, there may be several electron-hole pairs created, typically 2-3, but seven have been observed. The principle of exploiting the benefits of CM has been shown by integrating PbSe or PbS nanocrystals in quantum dot solar cell. Indeed, other materials can instantaneously offer better opportunities that can be in principle more economically viable and with lower environmental impact. Since the silicon (Si) technology is mature and dominates the solar cell market one could speculate that silicon nanocrystals (Si-ncs) could be good candidate. Investigations triggered out that silicon band gap is already too large and CM threshold appears only for high energy photons. Therefore alloying Si with another element, which decreases the band gap might offer the possibility of activating CM at lower photons energies by using a wider range of the solar spectrum. The silicon-tin ($Si_{1-x}Sn_x$) system is an interesting candidate as an optically active material where the concentration of Sn can be effectively used to extend the range of achievable bandgaps down to 0.45 eV while at the same time changing indirect band gap semiconductor to direct ones is expected. However, the drawback is that due to the large difference in size between Si and Sn atoms and $Si_{1-x}Sn_x$ alloys are inherently metastable. Very recently we have demonstrated the synthesis of semiconducting SiSn nanocrystals via a highly non-equilibrium spatially confined short pulsed laser process. In this contribution the potential of spatially confined plasma induced growth of the SiSn nanocrystals via kinetic pathways will be discussed. Our investigations suggest that alloying between Si and Sn can occur at relatively high Sn concentrations resulting in the synthesis of semiconducting SiSn nanocrystals with quantum confinement effects. Due to the successful alloying, quantum confinement and band gap narrowing the 250 nm red shift in PL maxima at room temperature is recorded with respect to the elemental Si-ncs. Furthermore we will show that an integration of SiSn nanocrystals into thin films allows adequate absorption and carrier transport for solar cells.

Acknowledgments: This work was partially supported by JSPS and a NEDO Project (Japan).