第76回応用物理学会秋季学術講演会 講演予稿集 (2015 名古屋国際会議場)

Influence of the transport properties in silicon nanocrystals/perovskites solar cells by nanocrystal surface and doping.

[1]Research Center for Photovoltaics, 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], Conor Rocks[2], Tamil Velusamy[2], Mickael Lozach[1], Davide Mariotti[2], Koji Matsubara[1],

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

Synthesizing the doped silicon nanocrystals (Si-ncs) with quantum confinement properties in principle enabling control of the band gap and the Fermi energy therefore it is supreme importance for tuning their optoelectronic properties. The position of the work function that can be tuned by nanocrystals doping which is crucial for band alignment, and their successful integrations in solar cell structure. Another issue is the have power over of surface properties of doped Si-ncs at quantum confinement size. Controlling interface between the host matrix (e.g. perovskites) and the Si-ncs is critical. In recent years we have developed and demonstrated advantages of surfactant free atmospheric pressure microplasma surface engineering of Si-ncs with quantum confinement size that can be used as an efficient tool to control electronic interaction of Si-ncs with various type of host matrices (e.g. conjugated polymers, nanocarbons etc.).

In this contribution boron doped p- and phosphorous n-doped Si-ncs with quantum confinement size (3 nm) are synthesized, surface engineered by atmospheric pressure radio frequency microplasma and integrated within perovskites based solar cells. Firstly, we demonstrate that surface engineering induce different surface chemistry as a function of the Si-ncs dopant. Secondly, we report that the absolute photoluminescence quantum yield is enhanced more than 3 times for n type Si-ncs compare to boron doped p type Si-ncs. Thirdly, the position of work function can be tune as a function of Si-ncs dopant and we report that work function increment is greater for surface engineered n-type than p-type doped Si-ncs. Next, the influences of the work function position in doped Si-ncs on hybrid Si-ncs/perovskites solar cell performance are demonstrated. Finally, the potential control of the diffusion length and transport properties through the Si-ncs doping and surface engineering in perovskites based solar cell is presented.

Acknowledgments: This work was partially supported by the Leverhulme International Network (IN-2012-136) JSPS and a NEDO Project (Japan).