ION-ASSISTED SELF-ORGANIZATION OF Si QUANTUM DOTS: EFFECTS OF PLASMA IONIZATION AND IONIC POLARIZABILITY

Dong Han Seo[1], Amanda E. Rider[1,2], Andrew D. Arulsamy[1], Igor Levchenko[2,1] and Kostya Ostrikov[2,1]

[1]*School of Physics, University of Sydney, Sydney NSW 2006, Australia*

[2]*CSIRO Materials Science and Engineering – Lindfield Lindfield NSW 2070, Australia*

In recent years, quantum dots (QDs) have received much attention in fields such as optoelectronics and photovoltaics. Quantum dots provide unique photo-absorption characteristics depending on their size. One of the major requirements in applications such as high efficiency photovoltaic device is size uniform quantum dots with sizes between (3~5nm) stacked in alternating layer (tandem structure) [1].

Traditional QD fabrication techniques, for example molecular beam epitaxy (MBE), which rely on typical growth modes such as Stranski-Krastanov (SK), result in the growth of size non-uniform QDs and require high processing temperatures[2]. However, utilization of ions during self-organization has been shown to successfully fabricate nanostructures at low processing temperatures[3].

Here, we have investigated the effect of silicon ions in different charge states ($Si^{1+,\ 3+}$) in fabricating size-uniform arrays of 1nm-sized Si QDs on a silicon carbide substrate. Moreover, the effect of varying the applied bias (-10V, -20V) in the Si^{1+} and Si^{3+} cases were compared to a neutral silicon atom case (in the absence of applied bias). This investigation resulted in an interesting effect, namely that the highest surface coverage was achieved using the lowest charge state ions (Si^{1+}) under a bias of -20V. The lowest surface coverage of 1nm QDs was achieved using neutral Si atoms in the absence of applied bias. This improvement was observed on a small scale, however it is expected that this effect can be further enhanced when the entire growth stage is taken into account.

1. G. C. Conibeer et al., "Silicon nanostructures for third generation photovoltaic solar cells", Thin Solid Films, vol. 511-512, 2006, pp. 654-662.

2. A. Fissel, Phys. Reports vol.379, 2003, pp. 149.

3. K. Ostrikov, I. Levchenko, S. Xu, "Self-organized Nanoarrays: Plasma-Related Controls", Pure. Appl. Chem., vol. 80, 2008, pp. 1909-1918.