Core-shell homojunction Si nanowire solar cells: Effect of shell growth and doping conditions on their photovoltaic properties

NIMS\textsuperscript{1} M. Dutta\textsuperscript{1}, N. Fukata\textsuperscript{1}

E-mail: DUTTA.Mrinal@nims.go.jp

Silicon nanowires (SiNWs) have been attracting a great deal of interest as a promising material for solar energy conversion to respond to the high demand for alternative renewable clean energy \[1\]. In contrast with planar cells, junctions in radial geometry of SiNW solar cells can maximize the light absorption by increasing the NW length and at the same time offer a short carrier collection path in the radial direction \[2\]. To exploit the advantages of radial p-n junction, it is necessary to form a defined junction. Contrary to undefined junction depths formed by diffusion process and unstability of Si NWs/organic polymer hybrid solar cells, chemical vapor deposition (CVD) has the advantage of amenability to extremely precise control of shell thickness, doping concentration and crystal growth orientation.

Core-shell homojunction SiNW solar cells were fabricated, using a combination of metal-catalyzed electroless etching (MCEE) to form n-SiNW arrays and thermal CVD techniques for the growth of boron (B) doped p-type shell layers, to study the effects of shell growth and doping conditions on the photovoltaic properties. The short circuit current (I_{sc}) and fill factor (FF) closely depend on the shell growth time and the B_{2}H_{6} gas flux. I_{sc} first increased and then decreased on increasing the shell growth time for the lower doping gas flux, while for higher doping gas fluxes I_{sc} monotonically decreased with increase of shell growth time. The increase in I_{sc} is probably due to the formation of the appropriate depletion layer depending on the shell thickness and the B doping concentration. The decrease in I_{sc} results from enhanced recombination of the photogenerated carriers due to high B doping.

Fig.1. FESEM images of (a) the Si NW arrays and (b) the core-shell NW arrays formed using 0.5 sccm B_{2}H_{6} gas flux for 5 min

Fig.2. Current-voltage characteristics of (a) solar cells for different doping gas fluxes for shell growth time of 8 min and (b) solar cells for 0.5 sccm doping gas fluxes for different shell growth times under AM 1.5G illumination.