18p-A4-14

ナノ結晶シリコン自立膜セルの高い開放光起電圧効果
Large open-circuit-photovoltage effect in nanocrystalline silicon membrane cells

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Nanocrytalline Silicon material (nc-Si) fabricated by electrochemical etching has been widely investigated for photonic applications since the discovery of its efficient visible luminescence due to quantum confinement in the material. The new physical properties and its relatively simple and cost effective fabrication process make the new material a good candidate for application in photosensors and new generation photovoltaic devices[1)]. In this paper, we are presenting our last results in photovoltaic characterization of the material.

Nc-Si material was produced by anodization of single doped (p and n) and diode type (pn and np) single crystalline silicon wafers. The thin layers were separated from the substrate resulting in nc-Si free-standing layers which were then contacted by different metals (Au or Al) or conductive oxide (ITO).

As shown in **Fig. 1(a),** under AM1.5-1 sun illumination, the pn type free-standing layers show definite photovoltaic characterisitcs[2)] with remarkably high Voc (~0.87 V) compare to single doped layers (Voc $\leq$ 0.3 V) and previous values reported in the literature (0.08V $\leq$ Voc $\leq$ 0.36V)[3)4)]. Their respective spectral response in **Fig. 1(b)** also show two distinct behaviors : the pn type layers features a response shifted toward higher energies compare to bulk Silicon and pinned at around 450nm (probably due to strong trapping in the material) while single doped n layers shows only a response in the UV region similar to Schottky type photodiodes. Current-Voltage characteristics as shown in **Fig. 1(c)** confirms that in single doped nc-Si material, the diode behavior originated from the metal/nc-Si interface (Au/nc-Si rectifying, Al/nc-Si ohmic) while in pn type sample, a diode behavior is present independently of the contacting material, confirming the existence of the junction inside the nc-Si layer.

Complementary investigations are underway to clarify the photoconduction phenomena and introduce new passivation techniques to enhance the performance of the devices for practical applications as a wide gap absorber in solar cells.

This work was partially supported by NEDO.

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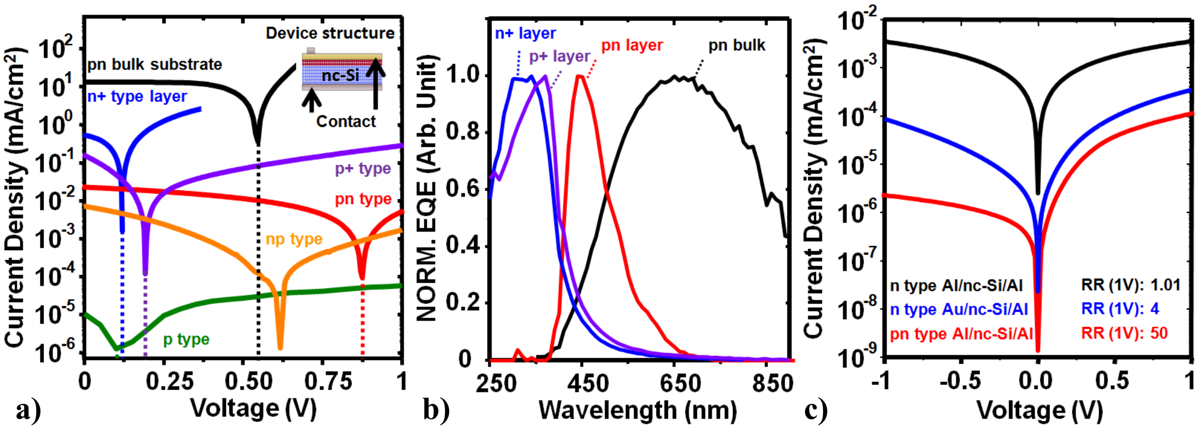

Fig. 1 (a) Comparison of PV characteristics of multiple nc-Si free-standing layers including pn type, singly doped p and n, and nc-Si/c-Si hetero-structure with inset showing the structure of the free standing nc-Si devices, (b) corresponding spectral response of three nc-Si layers and bulk silicon substrate as a reference, (c) IV plot for n and pn type nc-Si layers contacted with Au or Al in sandwich configuration.