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有機表面修飾したナノ結晶シリコン自立膜セルの光電特性

Photoelectrical characterization of organically surface-modified nanocrystalline silicon membrane cells

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Quantum-sized nanocrystalline silicon (nc-PSi) prepared by electrochemical etching has been widely investigated for photonic applications as a wide-gap luminescent material. As previously reported [1], self-standing nc-PSi layers exhibit definite photovoltaic properties with a sensitivity in the short wavelength region. Fabricated nc-PSi membrane solar cells show a significantly large open-circuit voltage [2]. Here we present the effect of surface modification on the photovoltaic performance.

The nc-PSi material was produced in the form of free-standing membranes through sequential nano-structuration of Si bulk material by wet electrochemical etching in a HF based solution under galvanostatic condition, followed by a separation of the upper layer from the original substrate. The resulting “free-standing” membranes were then chemically modified in neat organic solution through thermal hydrosylilation [3] of the original hydrogen terminated surface by various organic molecules (alkene, aldehide etc...). The layers were all contacted in sandwich configuration with metal or transparent conductive oxide for photo-electrical characterization.

The typical photovoltaic characteristics of as-prepared pn layers summarized together with free-standing layers made from p, p+ and n+ as well as the original Si substrate are shown in **Fig. 1(a)**. PV effects with large V_{oc} up to 0.87V are observable in pn type devices, a value of V_{oc} not reported in such devices so far [4-6]. Further investigations show that the contacting material has a minor effect and that the PV characteristic is strongly dependent on the surface passivation of the material. The effect of surface modification by organic molecules was first investigated on the time degradation of the observed photocurrent as seen in **Fig. 1(b)**. Strong to moderate stabilization was obtained depending on the organic molecule type, and modification of the spectral response and increase in the photocurrent were also observed in the case of modification by decanal as seen in **Fig 1(c)**. Further investigations are underway to clarify the contribution of the organic species on the observed photoconduction effect.

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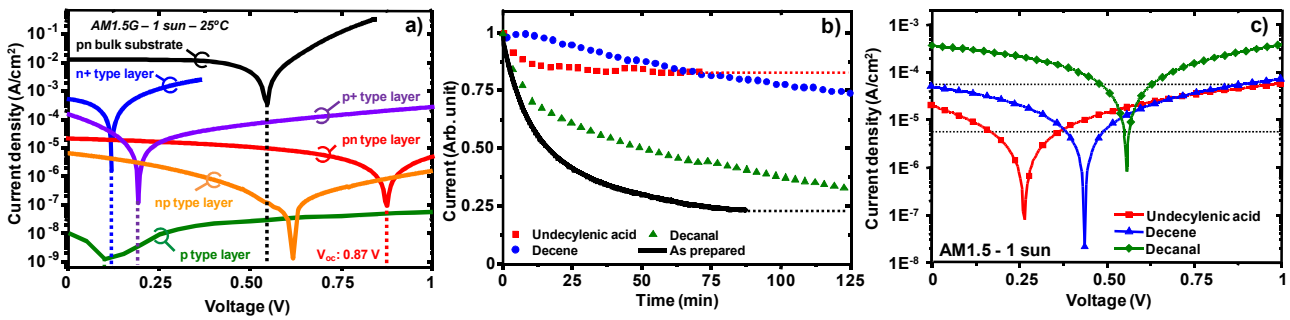

Fig. 1 (a) Comparison of PV characteristics of multiple nc-Si free-standing layers including pn type, singly doped p and n, and the original pn substrate, (b) Time variation of the photocurrent before and after surface modification with various organic molecules, (c) IV plot for pn type nc-PSi layers after different modifications showing increase in photo-generated current after decanal treatment.