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Novel Enhanced Flexibility of ZnO Nanowires Based Nanogenerators Using Transparent Flexible Top Electrode

강물결[1,2], 하인호[1], 김성현[1], 조진우[1], 주병권[2], 이철승[1]

[1]전자부품연구원 에너지나노소재연구센터, [2]고려대학교 디스플레이나노시스템연구실

The ZnO nanowire (NW)-based nanogenerators (NGs) can have rectifying current and potential generated by the coupled piezoelectric and semiconducting properties of ZnO by variety of external stimulation such as pushing, bending and stretching. So, ZnO NGs needed to enhance durability for stable properties of NGs. The durability of the metal electrodes used in the typical ZnO nanogenerators(NGs) is unstable for both electrical and mechanical stability. Indium tin oxide (ITO) is used as transparent flexible electrode but because of high cost and limited supply of indium, the fragility and lack of flexibility of ITO layers, alternatives are being sought. It is expected that carbon nanotube and Ag nanowire conductive coatings could be a prospective replacement. In this work, we demonstrated transparent flexible ZnO NGs by using CNT/Ag nanowire hybrid electrode, in which electrical and mechanical stability of top electrode has been improved. We grew vertical type ZnO NW by hydrothermal method and ZnO NW was coated with hybrid silicone coating solution as capping layer to enhance adhesion and durability of ZNW. We coated the CNT/Ag nanowire hybrid electrode by using bar coating system on a capping layer. Power generation of the ZnO NG is measured by using a picoammeter, a oscilloscope and confirmed surface condition with FE-SEM. As a results, the NGs using the CNT/Ag NW hybrid electrode show 75% transparency at wavelength 550 nm and small change of the resistance of the electrode after bending test. It will be discussed the effect of the improved flexibility of top electrode on power generation enhancement of ZnO NGs.

Keywords: ZnO, nanogenerator, piezoelectric, ZnO nanogenerator, transparent flexible electrode

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An Investigation on Gridline Edges in Screen-Printed Crystalline Silicon Solar Cells

Seongtak Kim, Sungeun Park, Young Do Kim, Hyunho Kim, Soohyun Bae, Hyomin Park, Hae-Seok Lee, Donghwan Kim[1]*

Materials Science and Engineering, Korea University

Since the general solar cells accept sun light at the front side, excluding the electrode area, electrons move from the emitter to the front electrode and start to collect at the grid edge. Thus the edge of gridline can be important for electrical properties of screen-printed silicon solar cells. In this study, the improvement of electrical properties in screen-printed crystalline silicon solar cells by contact treatment of grid edge was investigated. The samples with 60 Ω/□ and 70 Ω/□ emitter were prepared. After front side of samples was deposited by SiNx commercial Ag paste and Al paste were printed at front side and rear side respectively. Each sample was co-fired between 670°C and 780°C in the rapid thermal processing (RTP). After the firing process, the cells were dipped in 2.5% hydrofluoric acid (HF) at room temperature for various times under 60 seconds and then rinsed in deionized water. (This is called “contact treatment”) After dipping in HF for a certain period, the samples from each firing condition were compared by measurement. Cell performances were measured by Suns-Voc, solar simulator, the transfer length method and a field emission scanning electron microscope. According to HF treatment, once the thin glass layer at the grid edge was etched, the current transport was changed from tunneling via Ag colloids in the glass layer to direct transport via Ag colloids between the Ag bulk and the emitter. Thus, the transfer length as well as the specific contact resistance decreased. For more details a model of the current path was proposed to explain the effect of HF treatment at the edge of the Ag grid. It is expected that HF treatment may help to improve the contact of high sheet-resistance emitter as well as the contact of a high specific contact resistance.

Keywords: Si solar cells, Screen-printing, Electrical properties, Scanning electron microscopy, Ag paste, HF treatment