Radial junction silicon nanowire solar mini-modules grown on FTO/glass substrates

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Over the last decade, solar photovoltaics (PV) has a key role in providing energy worldwide. In 2016, the installed capacity of solar PV was around 303 GW, higher than the previous year by 75 GW [1]. However, due to the significant increase of annual global energy demand, an innovative approach of solar PV materials should be addressed. In addition, fabrication cost and material consumption must be maintained at competitive rates. Therefore, we have been studying radial junction silicon nanowire (RJ SiNW) solar devices fabrication to take advantage of strong light trapping and anti-reflection properties of NWs. The fabrication process of RJ SiNWs using plasma-assisted vapor liquid solid (VLS) is fully compatible with well-established industrial thin film technology [2]. In addition, RJ SiNW solar devices provide excellent performance stability under continuous light illumination with light induced degradation of ~6%, due to the ultra-thin intrinsic absorber layer of 100 nm. In this context, we have implemented laser scribing technique to fabricate mini-modules based on RJ SiNW solar cells, to obtain a monolithic series connection of the individual solar cells. The role of laser scribing is to remove certain amount of a selected layer by using an appropriate laser wavelength, in order to perform precise scribes with low mechanical stress and small area loss compared to mechanical scribing. The final design of mini-modules along with the scribes made on each layer is presented in the schematics in Fig. 1. Anl open-circuit voltage of 4.5 V and power generation of 13 mW have been achieved for 6 cells of 4.3 x 0.4 cm^2 area each on 5x5 cm^2 SnO_2:F/glass substrates. In addition, we have studied the fabricated SiNW solar mini-modules using electroluminescence (EL) technique to assess the uniformity as well as the presence of top contact resistance. Moreover, the structural properties have been assessed by scanning electron microscopy (SEM). The recent results have shown the potential towards competitive large area RJ SiNW solar panels. However, more studies should be conducted in order increase the performance to meet up with PV market. In addition, an advanced optimization of fabrication process flow and encapsulation of RJ SiNW mini-modules will encourage the industrial sector to embrace RJ SiNW solar devices.

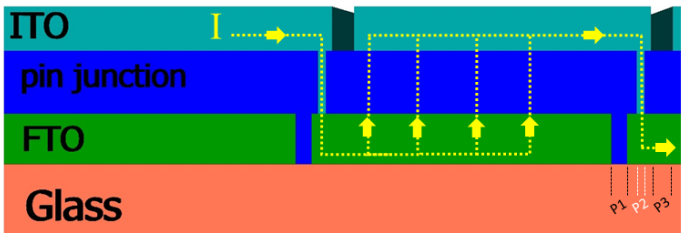

Figure 1: Schematics showing the geometry of laser scribed mini-modules. The yellow dashed line illustrates the electrical current path through the interconnected cells.

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