Transparent electrode for nanowire solar cells

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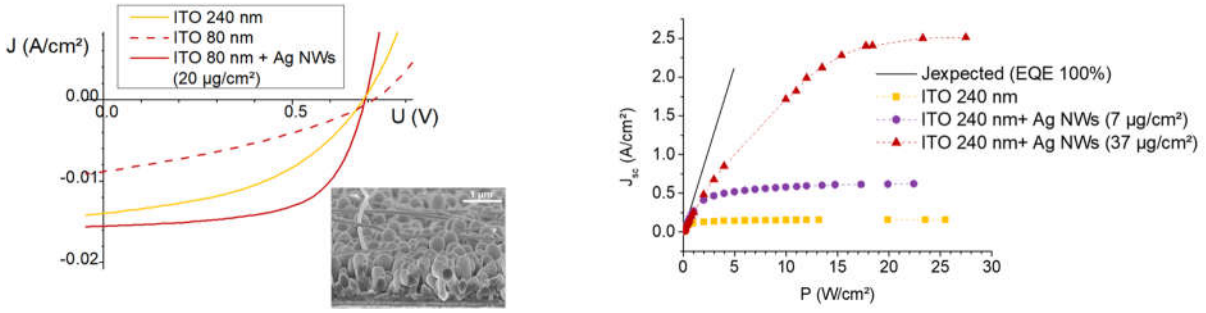
Nanowires (NWs) with radial junction geometry allow to decouple the light absorption and the carrier collection. This is particularly advantageous for lower-quality materials having short minority carrier diffusion lengths such as hydrogenated amorphous Si (a-Si:H). Solar cells made of Si/a-Si:H radial junction NWs can be highly cost-efficient since they can be grown on large areas at rather low temperatures (around 400 °C) with plasma enhanced chemical vapor deposition techniques, leading to energy conversion efficiency over 9%.[1]

However, the usual top-contacts for solar cells are not suitable for the dense array of non-uniform Si/ a-Si:H NWs. Due to the NW morphology, it is difficult to obtain a conformal conductive ITO layer by magnetron sputtering, which results in a sheet resistance for the top contact of several kΩ/□. We thus developed a hybrid electrode, made of ITO and silver NWs. The optimization of the ITO thickness and the Ag NWs density enables an increase of the conversion efficiency under 1 Sun (4.3% to 6.6%), thanks to an appropriate trade-off between the conductivity and the transmittance of the contact.

To test the limit of the top-contact, we use concentrated illumination (CI) from a laser source. The front contact is demonstrated to be the main limiting factor for illumination exceeding 0.2 W/cm². Up to this power, the short-circuit current density follows a linear dependence with illumination power, then it exhibits a saturation due to the high in-plane resistance of the top contact [Fig. 1(b)]. The use of Ag NWs is shown to lead to a ca. 15-fold increase of the current density and the conversion efficiency under the CI.



(a) (b)

Figure 1: (a) JV curves under 1 Sun for a 7 mm² cell (inset: SEM cross-section with hybrid contact), (b) Jsc at different illuminating powers for Si/a-Si:H NW solar cells with and without Ag NWs.

References :

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