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Data article

Data supporting the role of electric field and electrode material on the improvement of the ageing effects in hydrogenated amorphous silicon solar cells

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ABSTRACT

Hydrogenated amorphous Si (aSi:H) solar cells are strongly affected by the well known Staebler–Wronski effect. This is a worsening of solar cell performances under light soaking which results in a substantial loss of cell power conversion efficiency compared to time zero performance. It is believed not to be an extrinsic effect, but rather a basic phenomenon related to the nature of aSi:H and to the stability and motion of Hrelated species in the aSi:H lattice. This work has been designed in support of the research article entitled “Role of electric field and electrode material on the improvement of the ageing effects in hydrogenated amorphous silicon solar cells” in Solar Energy Materials & Solar Cells (Scuto et al. [1]), which discusses an electrical method based on reverse bias stress to improve the solar cell parameters, and in particular the effect of temperature, electric field intensity and illumination level as a function of the stress time. Here we provide a further set of the obtained experimental data results.

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Specifications table

Subject area	Physics
More specific subject area	Photovoltaics
Type of data	Tables, figures
How data was acquired	Cascade probe station with micro chamber - HP 4156B semiconductor parameter analyzer - 92191–1000 Newport solar simulator - Thermostatic chuck with a Temptronic thermal controller working under N_2 flux
Data format	Analyzed
Experimental factors	The hydrogenated amorphous Si (a-Si:H) solar cells used in the present study were single-junction p–i–n cells with p and n-type a-Si:H layers of both 20 nm thicknesses and intrinsic (i) a-Si:H layer of various thicknesses. The analyzed samples had a AGC ASAHI GLASS VU-type substrate with ≈ 700 nm thick SnO_2:F as transparent conductive oxide (TCO) deposited by sputtering; the cells were deposited by plasma enhanced chemical vapor deposition (PECVD) under the same conditions at 255 °C; the top electrode was a 900 nm thick ZnO:Al (AZO) TCO. The entire solar cell layer sequences was glass substrate/SnO_2:F/p–i–n a-Si:H/AZO. The final geometries (circular with diameters varying from 0.01 to 0.64 cm) were defined by photolithography and selective etching of the AZO/p–i–n films.
Experimental features	All the solar cell electrical measurements were performed in substrate configuration, i.e. with the illumination light entering from the top AZO contact.
Data source location	Institute for Microelectronics and Microsystems, National Research Council, Catania, Italy
Data accessibility	Data are with this article

Value of the data

- The solar cell improvement under reverse bias stress application is quantitatively reported;
- Data of the temperature dependence of the solar cell parameter change under reverse bias stress are shown;
- Clear evidence of the reversibility of the solar cell parameter change depending on the polarity of the applied stress is shown.

1. Data, experimental design, materials and methods

1.1. Light induced degradation of solar cells under short circuit condition

To define the sample preparation conditions we have studied the role of the H_2/SiH_4 ratio during the PECVD deposition of the a-Si:H layers at 255 °C on the time zero performance of the solar cells, given the important role played by the H_2 dilution [2–6]. We prepared two different typologies of samples using various different dilution ratios *R*, defined as the H_2/SiH_4 ratio. A number of a-Si:H solar cell types were used in this analysis. One group was single-junction p–i–n cells with p and n-type a-Si:H layers of both 20 nm thickness and with the intrinsic (i) layer of either 45 nm or 250 nm thickness. The second group was a tandem a-Si:H/a-Si:H cell where the two i layers were 45 nm and 250 nm, respectively. Fig. 1 shows the *I–V* characteristics of these samples measured under AM1.5G spectrum with illumination intensity of 1.5 suns. From the figure it is evident that in each case the samples with $R=5$ dilution show better short circuit current. The effect is attributed to a better photo-carrier lifetime. In all cases, however, the a-Si:H films are amorphous, not micro-crystalline, and without any clear sign of Si nanocrystals, as shown by Raman and TEM analysis (not reported). For all the experiments reported in the following part of the paper, we have used single junction a-Si:H solar cells with 250 nm *i* layer and prepared with a dilution *R* equal to 5.

To study the degradation of our solar cells under light soaking and, consequently, to define a reference baseline, we have analyzed the effect of light soaking stress under short circuit conditions