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Panasonic's R&D on Photovoltaic Technologies

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Abstract

The history and recent activity of R&D on photovoltaic technologies in Panasonic, such as thin film silicon and HIT solar cells were reviewed.

1. Introduction

Global attention to photovoltaics as a promising means of ideal renewable energy resource is increasing year by year. To enable solar cells to significantly contribute to preserving the measure energy resources, continuous cost-reduction of modules and systems is necessary.

2. Thin Film Silicon Solar Cells

We has conducted R&D on silicon based solar cells for more than 30 years, and released the first a-Si solar cell products in 1980. Thin-film silicon, such as a-Si, µc-Si and related alloys are promising materials for very low-cost solar cells. We have been developed high performance a-Si/µc-Si tandem solar cells. The world top level stabilized conversion efficiency of 10.7% was achieved for a large (G5 size) module (Fig.1, 2) [1].

Fig. 1 Large-area a-Si/µc-Si tandem modules.

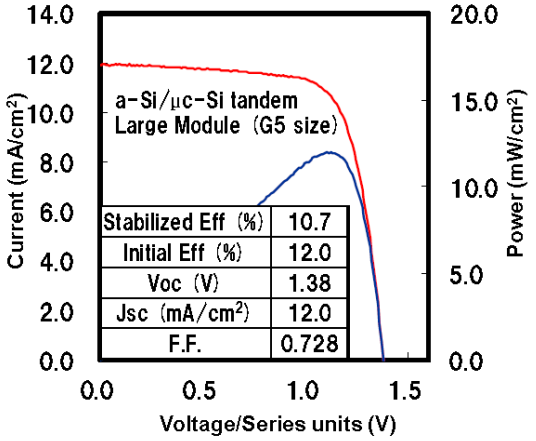

Fig. 2 I-V characteristics of a large-area a-Si/µc-Si solar module measured under AM 1.5, 100 mW/cm^2 light.

3. HIT Solar Cells

On the basis of a-Si technology using PECVD, a-Si/c-Si heterojunction structure called HIT (heterojunction with intrinsic thin layer) was developed in 1990 [2, 3]. HIT solar cells have following features; (1) excellent surface passivation which resulting in high voltage and high efficiency, (2) low-temperature processes (<200_C) which prevent any degradation of solar grade CZ c-Si, (3) excellent temperature coefficient.

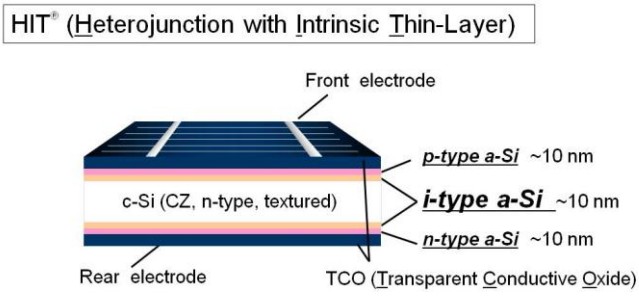

Fig. 3 Schematic illustration of HIT solar cell.

Figure 4 shows the progress in the efficiency of HIT solar cells. We have successfully applied our high- efficiency processes to very thin silicon wafers of less than 100µm thick at the R&D stage (Fig.5) [4]. Recently, we achieved the new record efficiency

of 24.7% for practical size (102cm^2) HIT solar cell (Fig.6).

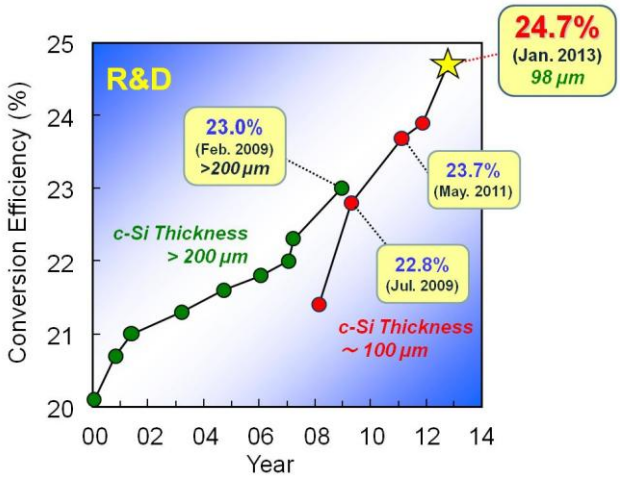

Fig. 4 Progress in the efficiency of HIT solar cells.

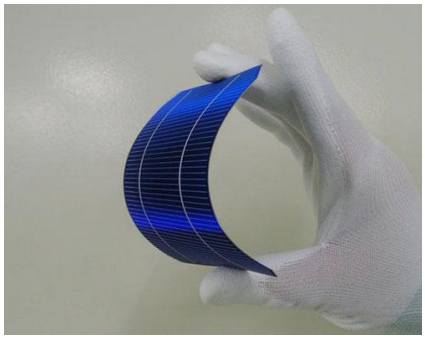

Fig. 5 Very thin HIT solar cell (<100μm).

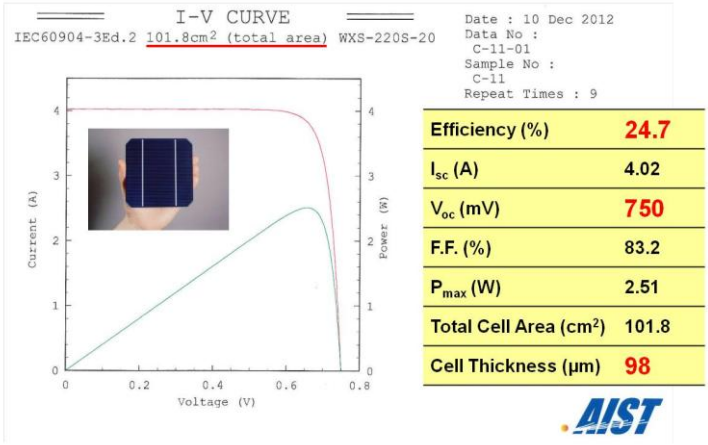

Fig. 6 I-V characteristics of HIT solar cell.

4. Innovative Deposition Technologies

Positioned as future technologies, we are also studying thin film silicon deposition processes that don't use vacuum equipment, so called "Liquid Silicon (L-Si) printing.

Figure 7 shows a schematic illustration of a printing process for a-Si using nano-dots. Nano-dot films were formed with the cooperation of the SHIMODA Nano-Liquid Process Project [6]. We applied this composite material to pin solar cells, and confirmed that it works (Area: 1 cm^2, Voc: 488mV, Jsc: 0.18mA/cm^2, F.F.: 0.35, Pmax: 0.031mW/cm^2) [7]. This is the first a-Si/nano-dot composite solar cell to be fabricated by a printing process from a liquid silicon source, although the conversion efficiency is still quite low.

These investigations are steps toward fully printed solar cells without the use of any vacuum equipment.

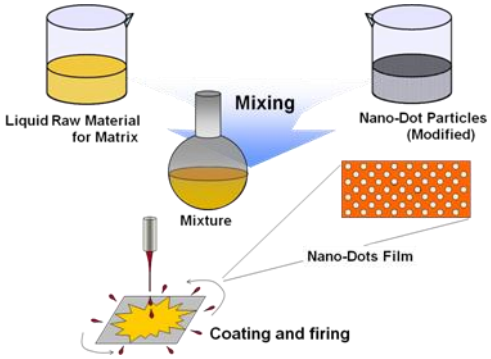

Fig. 7 Schematic illustration of a-Si printing process.

5. Conclusions

We achieved very high performances for both thin film silicon and HIT solar cells, We are also challenge to innovative technologies.

Acknowledgements

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Appendix

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