Comparing Thin-film Gallium Arsenide and Amorphous Silicon Solar Cells for Energy Harvesting Applications

Contents

Introduction

Since the late 1970s, amorphous silicon (a-Si) solar cells have been used to power small devices such as calculators and watches. Solar cells made from amorphous silicon typically convert between 3% – 6% of incident light energy into electricity (this is referred to as the conversion efficiency). Despite having small conversion efficiency, this thin film technology was used over other types of solar cells due to relatively good performance in indoor light, and the ability to manufacture it in lightweight and flexible form factors, easing integration into products such as solar fabrics, cylindrical products, and lightweight charging mats.

When choosing between two thin-film technologies, another important factor to consider is the in-field performance over the expected product lifespan. There is a phenomenon that occurs in amorphous silicon known as the Staebler-Wronski effect. Thin film amorphous silicon typically undergoes degradation when exposed to light. The result of this effect is an efficiency reduction for amorphous silicon cell of 10-30% within the first 1000 hours of operation. The degradation can be partly reversed, by annealing the amorphous silicon solar cells at high temperatures such as 150°C (300°F), but heating to this temperature is impractical for applications where the solar cell is integrated into a finished product.

This paper compares the degradation over time of thin film gallium arsenide against amorphous silicon in the same environment and time frame.

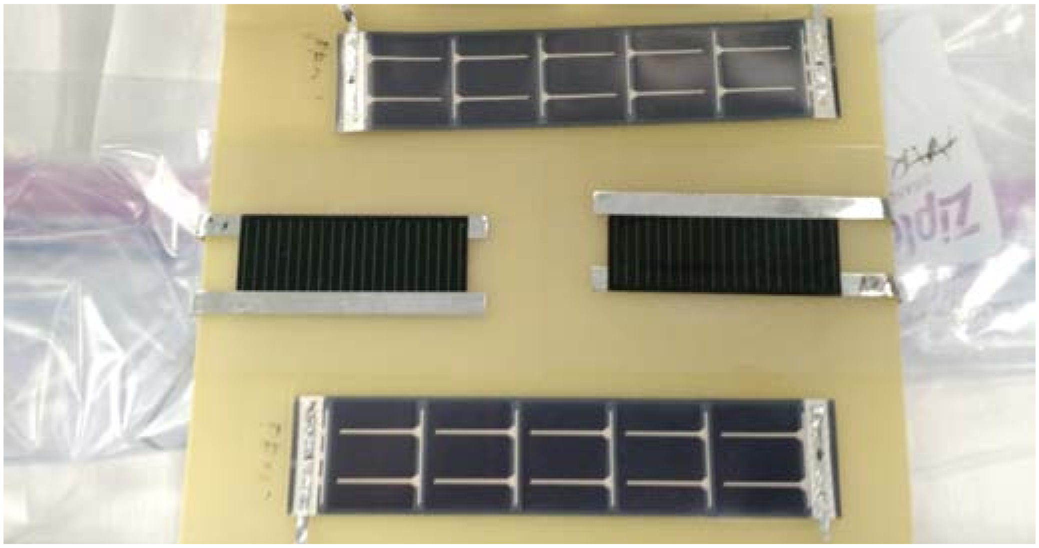

Fig. 1. Test plate with 0.21 watt thin film gallium arsenide solar cells (smaller cells) and 0.10 watt amorphous silicon solar cells

Experiment

In the experiment, thin film gallium arsenide and thin film amorphous silicon solar cells were placed side by side in a transparent container on the roof of Alta Devices' factory in Northern California. The cells were periodically tested for performance. We used our production solar simulator and current-voltage tester which are calibrated daily for measurements under AM1.5G, 1000W/m^2 spectrum. This tester is kept in calibration to within 2% error.

Data Analysis

Figure 2 shows power over time for both technologies. In figures 3 and 4, we show power per area over time. In figure 5, we plot the normalized power degradation and observe 22% degradation in the amorphous silicon cells over the span of just 18 days. The gallium arsenide cells saw virtually zero degradation in the same time frame.

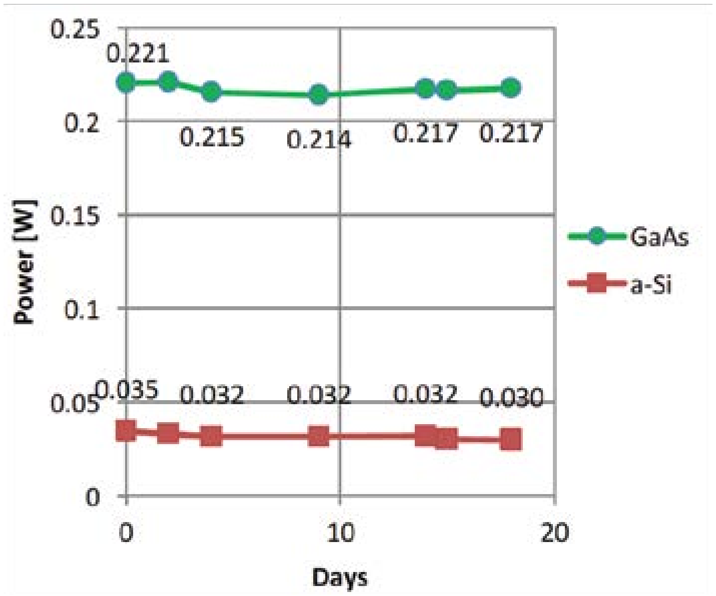

Fig 2. Power over time for gallium arsenide and amorphous silicon cells

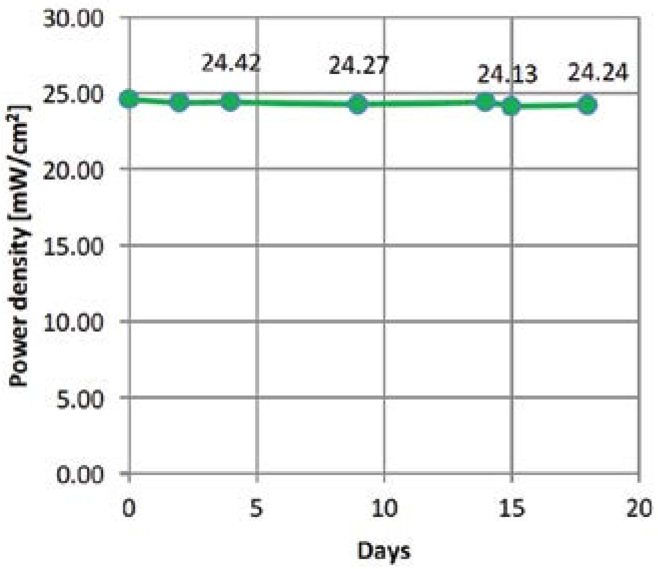

Fig. 3. Power per area over time for gallium arsenide

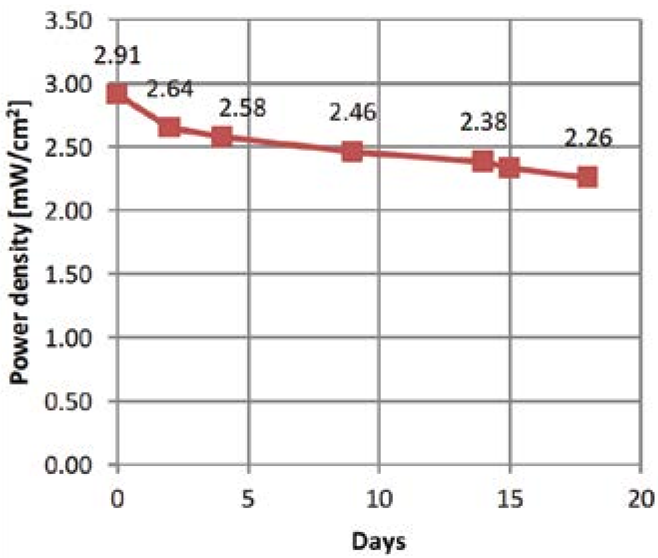

Fig 4. Power per area over time for amorphous silicon

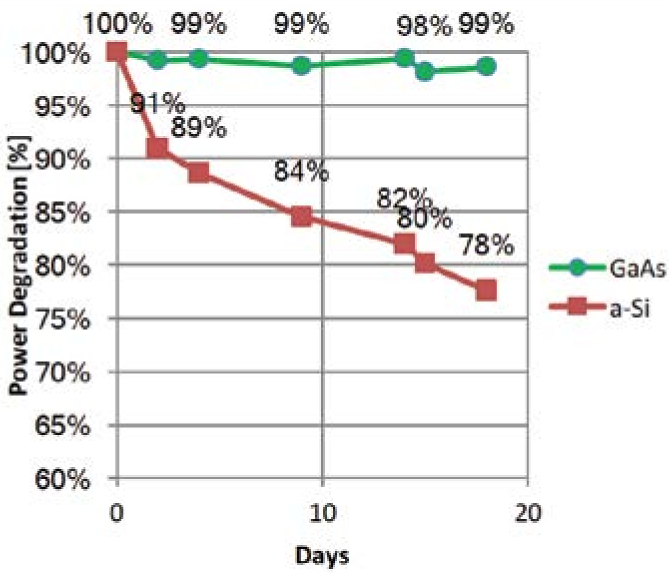

Fig 5. Power degradation percentage over time for gallium arsenide and amorphous silicon

Conclusion

Designers can choose from a wide range of available solar cells and must carefully evaluate the significant performance tradeoffs resulting from that choice. In this whitepaper we have presented a simplified performance index for comparing the power density of solar technologies. The index places a premium on simultaneous minimization of weight and surface area. With the effects of encapsulation taken into account, thin GaAs solar cells score over 2x better than the nearest alternative and are an excellent choice for designs seeking high performance while minimizing weight and surface area.

ABOUT ALTA DEVICES

Alta Devices (www.altadevices.com) holds the world record for single-junction solar cell efficiency (28.8%). It manufactures ultra-lightweight gallium-arsenide based solar cells in its Sunnyvale, California factory and provides application engineering support to OEM customers worldwide. Alta Devices can be contacted at info@altadevices.com.

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