

International Standards: a critical step towards reducing PV manufacturing cost

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ABSTRACT

Many readers will equate SEMI with the SEMICON trade shows around the world, business and technical conferences, EHS and advocacy initiatives and, most of all, industry standards. Currently, SEMI has close to 2,000 member companies, about 20% of which are active in the photovoltaic sector. These companies form a community called PV Group.

The mission of the PV Group is to serve the photovoltaic market with events, standards and services. Working with other industry groups throughout the world, SEMI is dedicated to advancing the growth and profitability of its members, and to achieve overall cost reduction to enable PV energy adoption worldwide.

We listen closely to our constituents' needs and are committed to developing unique approaches to unique problems. Connecting markets and industries that benefit from dialogue has been our mission for 38 years. Between former semiconductor professionals moving into PV, pure PV manufacturers and a startling number of start-ups, there is fertile ground for collective discussions in all regions of the world that are necessary to propel us forward.

SEMI International Standards Program

The SEMI International Standards Program, established in 1974, is celebrating its 35th anniversary this year. 35 years of continued growth in technology breadth, geography and people have led to close to 800 SEMI Standards and Safety Guidelines collectively developed by volunteer experts around the world for the continued improvement of equipment, materials and processes for a variety of industries.

What started with the historic agreement on a universal wafer diameter in semiconductor processing evolved over the years into a global, all-encompassing volunteer program of currently 1,800 individuals. The program has embraced new and emerging technologies in all corners of the planet, along with the people who populate the technical committees and task forces. The Standards Program has been the foundation and launching pad for the

innovative spirits needed to tackle new manufacturing challenges and new business opportunities. It is vital to a sustainable global supply-chain and market community.

Determining where standards can strengthen weak links, open borders and create a global understanding and acceptance of PV manufacturing challenges is difficult but possible if stakeholders work together.

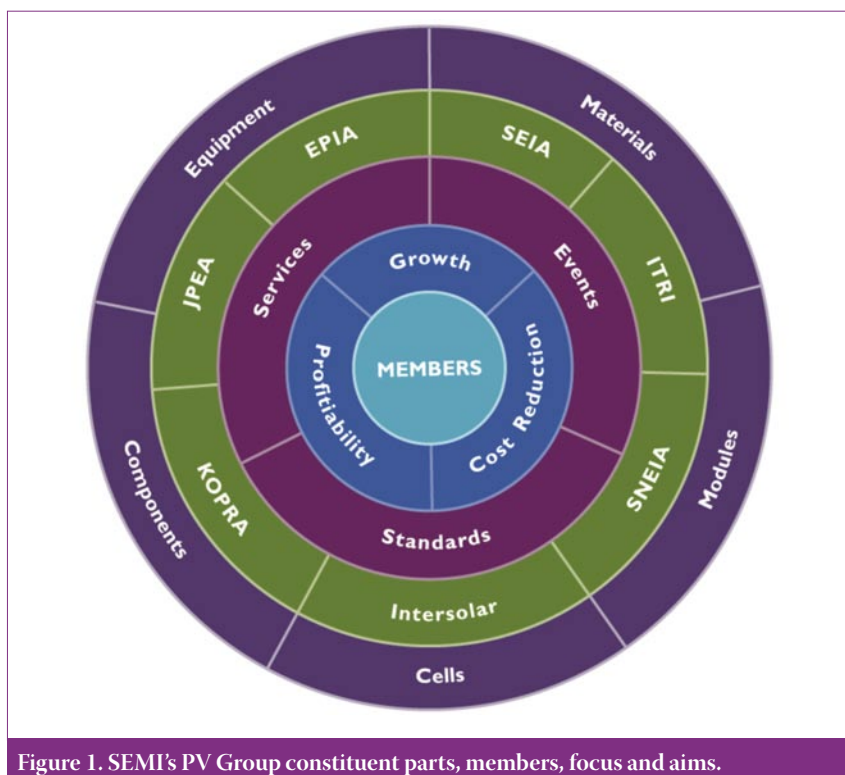


Figure 1. SEMI's PV Group constituent parts, members, focus and aims.

Why PV standards?

PV standards are urgently needed in the industry. Representatives of our member companies – as well as their customers – have remarked on the fact that they experience a lack of agreement on basic parameters, that materials specifications and test methods vary and that industry stakeholders are worried about giving up their intellectual property for the collective good with no gain for themselves. The long answer to the question of why PV standards are so urgently required is more complex. For starters, it is not entirely obvious where consensus standards are needed, and when. Pain points, such as cost, waste,

time-to-market and environmental concerns, could clearly be addressed by standardized approaches but lack the collective industry voice to move forward. Secondly, several standards-developing organizations (SDOs) are active and could, potentially, create more confusion and delays. And thirdly, there are the complexities that come with a global market and a global supply chain. Determining where standards can strengthen weak links, open borders and create a global understanding and acceptance of PV manufacturing challenges is difficult but possible if stakeholders work together with common objectives, determination and a collaborative spirit.

PV standards efforts in SEMI

As soon as SEMI member companies began expanding into the photovoltaic space, and SEMI began developing supporting products and services to ease the transition, 'Standards' was the first key word that entered the equation. At the first informal Photovoltaic Standards meeting in September 2006, executives from the PV industry discussed where SEMI could most positively influence and contribute to the growth of the PV industry. Standards at the manufacturing equipment and materials level were identified as both missing and absolutely critical in order to lower trade barriers

and reduce cost of ownership for cell and module manufacturers.

Within a year (2007), both Europe (with support and endorsement from EPIA, the European Photovoltaic Industry Association) and North America established formal PV Standards Committees and jointly produced the following global committee charter:

Explore, evaluate, discuss, and create consensus-based standard measurement methods, specifications, guidelines, and practices that, through voluntary compliance, will promote mutual understanding and improved communication between users and suppliers of photovoltaic manufacturing equipment, materials and services to enhance the manufacturing efficiency and capability so as to reduce manufacturing cost of the photovoltaic (PV) industry.

While there is agreement on the overall scope (and limitations) of work to be done, Europe and North America started their efforts in different areas. In the spirit of developing standards 'by the industry, for the industry', the first working group to be established under the North American PV Standards Committee was the Analytical Test Methods Task Force, led by Evans Analytical Group.

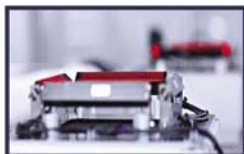
This task force has developed a draft document titled *Test Method for the Measurement of Elemental Impurity Concentrations in PV Silicon Feedstock by Glow Discharge Mass Spectrometry*.

Ongoing standardization work is a step towards the future, but it may not beat the speed of innovation and growth we currently see.

The ballot failed technical review and will be re-balloted with revisions based on the feedback received, which will naturally make it a better standard in the end. This is one of the biggest benefits of a global Standards development process, as even if a company does not participate actively in a task force or committee, it will have the opportunity to review and comment on the drafts prior to approval and publication, ensuring that additional perspectives and obstacles are being addressed that may have been missed during the first round. And with seven ballot cycles per year, the volunteer experts in the SEMI Standards Program do not have to sacrifice quality for speed.

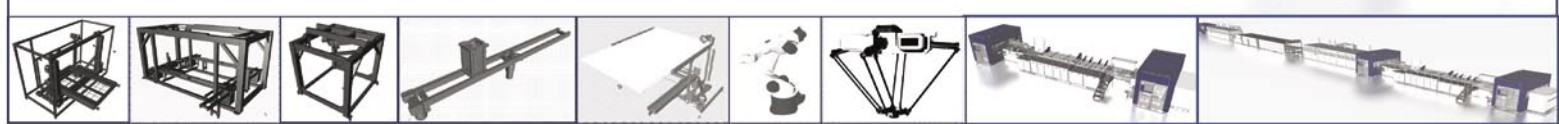
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- automation for the solar cell manufacturing
- modular standard concept for efficient realization
- customize solutions (silicon based production/ thin film)



Standard program:

- CellWaTest check of incoming wafers for quality assurance
- CellRoSin automatically load- & unload machine for SINA
- CellRoTrans transfer of wafers between the process machines by robots
- CellRoTest quality inspection of cells



The second North American PV Standards Task Force, led by Mark Frederick of Entegris, is currently drafting a *Specification on 150mm, 156mm, and 200mm wafer and cell transfer carriers for use in PV manufacturing*, which will be distributed as a technical ballot later in the year.

The results of a third ballot, *Revision to SEMI M6-0707 Specification for Silicon Wafers for Use as Photovoltaic Solar Cells*, were reviewed at the North American PV Standards Committee meeting, where the document was approved for publication. This particular document now includes the 156mm x 156mm wafer specification, which is widely used in the PV industry.

In Europe, on the other hand, an at times heated debate over equipment interfaces appears to have just been resolved. The PV Equipment Interface Specification Task Force (PV-EIS TF), chaired by SolarWorld and Manz Automation, worked through a challenging time of discussions around the issue of whether or not SECS/GEM will be the present and future interface in PV manufacturing, and the answer is a resounding 'yes', especially since major cell manufacturers have supported this choice, which in turn should come as a relief to equipment vendors. The task force issued a draft of its *Guide for PC Equipment Communication Interfaces* as an information ballot during PVSEC in Valencia, Spain in early September. This document referenced existing semiconductor standards that are applicable to PV manufacturing with only minor modifications.

Other regions are coming up to speed very quickly. Taiwan, for example, assembled a SEMI PV Standards Working Group within a very short period of time, with the aim of becoming a formal regional committee in the near future. Chaired jointly by Chroma, Delsolar, PVTC/ITRI and UL Taiwan, the working group aims at investigating standards opportunities in the following areas, and has already established subgroups on all of these issues:

- Si feedstock
- Cell performance
- System performance
- Module performance
- Equipment interfaces (liaison with EU PV-EIS TF).

SEMI Global PV Standards Roadmap

Ongoing standardization work is a step towards the future, but it may not beat the speed of innovation and growth we currently see. In order to provide both a truly global platform for solar standardization as well as an outlook of future requirements that will impact

today's design, manufacturing processes and end products, SEMI is spearheading a Global PV Standards Roadmap project. A core team of equipment and materials suppliers, cell and module makers, academia and other interests was established in May 2009. After two teleconferences, core team members met at SEMICON West 2008 to begin development of a Roadmap Project Plan which will define the purpose and scope of the Roadmap, the timeline it will cover, and of course the individual elements it will address, such as materials, process equipment, environmental, health and safety considerations, facilities aspects, critical cell and module issues and drill down into areas where a standardized approach will help mitigate risks, reduce costs, improve time-to-market and cost of ownership. Completion of the Project Plan is tentatively scheduled for December 2008.

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Phase 2 of the Roadmap project is designed to be a broad, global industry effort to develop substantive, consensus-driven content to the individual Roadmap elements. Supported by a strong SEMI marketing and communications plan, SEMI and the core team will disseminate regular updates about Roadmap development, recruit experts to aid in the effort and communicate the results to a broad audience on a regular basis. Phase 2 is currently projected to be concluded by the end of 2009, or earlier if possible. Core team members agree that this document has to be made available to the industry as soon as possible and is working with a sense of urgency and speed to make it happen.

Phase 3, the actual development of Standards to address the needs and requirements identified in the Roadmap, is envisioned to overlap with Phase 2, and we expect many volunteer experts to be active in defining the requirements as well as aiding in the document development process.

Partnerships and strategic alliances

While these activities and initial results are very encouraging, we realize that no organization can do all the work that needs to be done single-handedly. For several decades, SEMI has partnered with other Standards Developing Organizations (SDOs), institutes and associations to engage not only SEMI member companies and their customers, but also any community that is impacted by the results a published standard offers.

This is not only true for standardization, but for many other related areas as well, such as EH&S, sustainability and environmental stewardship activities, which will require close collaboration among participating countries, in particular with respect to new regulatory and compliance legislation. This will likely impact the development of related PV Safety Guidelines to address unique challenges in the areas of hazardous materials, waste management, raw material supply, etc.

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About the Author

Bettina Weiss has been working with SEMI for 12 years. She joined the SEMI Europe office in Brussels, Belgium in 1996 as Standards Coordinator and transferred to SEMI Headquarters in spring of 1997 where she worked in several Standards-related positions. From November 2003 to March 2008, she served as Director, International Standards as chief staff of the SEMI International Standards Program.

Since April 1, 2008, she has held responsibility for all initiatives and activities in SEMI's photovoltaic segment in North America, with continued global responsibility for PV standardization efforts as well as successful execution of the PV Standards Roadmap project. Prior to joining SEMI, Bettina worked in marketing and sales positions at Metron Technology and Varian Semiconductors in Munich, Germany.

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