The SEMI International Standards Program – History, Successes and Lessons Learned to Address Compound Semiconductor Manufacturing Challenges

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ABSTRACT

The history of SEMI and its International Standards Program are described as a forum and mechanism to develop critical global industry standards that are widely applicable. This presentation will explain past and current successes, challenges, milestones and lessons learned and provide suggestions for increasing the value and industry impact of compound semiconductor standards worldwide.

INTRODUCTION

SEMI was founded in 1970 as a trade show association, primarily to support the small but growing semiconductor equipment segment which needed formal representation. In the early 1970s, semiconductor device manufacturers were still vertically integrated and coped with the entire manufacturing process in house, from pulling silicon ingots, to wafer processing to packaging, final test and assembly, without outside suppliers or subcontractors. Over the next several years, SEMI’s portfolio of products and services quickly grew to address areas such as advocacy, Standards, technical programs and conferences and market statistics. It is the area of SEMI Standards that is being described here more closely.

HISTORY

In the 1970s, silicon was already the established material of choice for integrated circuits, but consensus-based industry standards were virtually non-existent. Custom-made solutions for each individual customer were the norm.

INTERNATIONALIZATION

The early successes in silicon set the stage for other areas to follow, such as chemicals/gases, facilities, safety/EHS, lithography, test, assembly and packaging and many more. Semiconductor standards
work carried out in the US also attracted the
attention of organizations in other regions, such as
JEIDA (Japan Electronics Industry Development Association) in Japan. For example,
the Japanese developed silicon standards roughly
at the same time as SEMI, but approach and
results were quite different. Increased
communication across regions, personal
interaction of stakeholders and the need for
cooperation brought Japan and the U.S. and
gradually other regions closer together. DIN
(Deutsches Institut fuer Normung) in Germany
and ASTM (American Society for Testing and
Materials) in the U.S. joined the effort, and to
this day participates in joint, SEMI-hosted
organization meetings on standardization.

The 1980s also witnessed the emergence
of SECS/GEM standards (SEMI Equipment
Communication Standard/ Generic Equipment
Model) which continue to be the basis for fab
communication. Before the SEMI SECS
standards were developed, there was a veritable
Tower of Babel in the fabs. Tools from different
suppliers couldn’t talk to each other. Manufacturing Execution Systems were different,
and there was no standardized computer-to-
computer communication system between
equipment and shop floor MES. SECS let all
these different tools and MES communicate.

The internationalization of the activity and
the increasingly sophisticated fab requirements
led to a heightened awareness of standardization
needs and the benefits consensus-based global
standards provide to the industry. This trend
continues today as cost for custom application in
factory integration, automation and architecture
have grown exponentially.

SEMI INTERNATIONAL STANDARDS
PROGRAM TODAY

Today, over 1,300 industry experts are
enrolled in the SEMI International Standards
Program, lending their expertise to the successful
development and deployment of global
specifications and test methods that help reduce
manufacturing cost, speed up time to market and
provide an industry-wide understanding of best
practice. 17 global technical committees with
hundreds of task force as well as close links to
the ITRS (International Technology Roadmap
for Semiconductors) and other industry
organizations ensure a continuous dialogue among
stakeholders (Figure 1).

But more commitment and proactive
thinking is needed in order to continuously develop
standards as enablers of and solutions for technology
trends. Involving device manufacturers and suppliers
of equipment and materials early on to determine not
only the technical requirements for a new
standardization project but also discuss the economic
feasibility associated with large industry trends
remains a challenge. The value proposition of SEMI
Standards – the benefits of developing and using
them but also the opportunities for exchange that this
neutral framework brings to the industry – need to be
communicated to higher level executives just as
much as to front line process engineers.

SUCCESSES AND LESSONS LEARNED

One example where timely and consensus-
based standards development paid off was when a
major device manufacturer opened its fab in Ireland
in the early 1990’s. A requirement for all tools
purchased for this fab was compliance to SEMI S2-
91, SEMI’s flagship semiconductor manufacturing
equipment safety guideline. By engaging suppliers
early on, this particular device maker was able to
significantly reduce fab ramp-up cost by providing
uniform equipment safety specifications which the
suppliers in turn could already build into the design
stage of their equipment.

The transition to 300mm wafers provided
further opportunity for standardization and produced
solid long-term results, especially in the area of
physical interfaces and carriers. A SEMI survey
conducted in 2003 showed that 62% of the 85
respondents saw an increase in the use of SEMI
Standards since 300mm specifications were
published (Figure 2).

For 300mm software, however, the results
were different and challenges have just recently been
completely resolved. While standards areas such as
metrics, EHS and silicon stabilized early on, software
revisions, frequent rebaloting and consequent “bug
fixing” in the field resulted in an estimated $200
million price tag for the semiconductor industry
collectively. The lack and delay of a collaborative
approach among device manufacturers and suppliers
has been openly acknowledged by representatives of
the device community, who vowed not to repeat this
mistake in the future. Now that 300 mm “prime”
(second generation/mature 300mm) issues,
particularly in the area of automated material
handling systems are being investigated and addressed, the device community has recognized the importance of developing standards and together with the supplier, to collaboratively develop industry guidelines for feedback and buy-in and to constructively look for ways to reduce cost. With R&D funding dwindling in our industry, standards will continue to be critical enablers for survival.

Emerging Technologies, such as MEMS (micro-electromechanical systems) provide fertile ground for standards as applications and products migrate from R&D to beta lines to commercialization. Last year, a Preliminary Standard was developed within only eight months that provides guidelines for generic fluidic I/O design and fabrication that can reduce redundant engineering effort and lead to improved design, manufacturability, testing, and operation. With strong backing from his management and his own personal commitment, the task force leader was able to bring together interested companies, achieve consensus on the concept, develop a well-defined timeline and milestones and achieve the fastest publication of a document in years.

OPPORTUNITIES FOR THE COMPOUND SEMICONDUCTOR INDUSTRY

The compound semiconductor segment can benefit from the successes and lessons learned, and work is already underway in various task forces of the Global Compound Semiconductor Committee. Identifying areas of high cost and time investment often point to processes where a standardized approach can help reduce the pain of low repeatability and high failure rate. The second aspect is the economic analysis about the potential impact and benefit a standard could provide, alongside the technical requirements that were identified. Thirdly, utilizing existing resources such as the ITRS, customer guidelines and a close watch on technology trends typically contribute to mitigating risk and improving productivity. Last, but certainly not least, is the benefit of having a global forum where stakeholders can come together, establish a sense of community and agree on common ground rules (standards) while maintaining the possibility of distinguishing their products through special features/enhancements. The key to success lies in early stakeholder involvement and the realization that more often than not this is a collective effort among competitors and their customers, for the greater – and quite tangible – benefit of cost reduction and fast time-to-market.

CONCLUSION

For over 30 years, SEMI Standards have played a vital part in improving materials, equipment performance, processes and many other aspects of semiconductor manufacturing, resulting in significant cost savings and time-to-market improvements for the industry and individual companies. Standards play a particularly important role in any technology transition and provide an opportunity for the compound semiconductor industry to review current challenges and apply standardization approaches where appropriate and needed. The SEMI International Standards Program will provide the necessary infrastructure for successful Standards development, enhanced industry stakeholder interaction and industry growth.

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ACRONYMS

JEIDA: Japan Electronics Industry Development Association; now JEITA Japan Electronics Industry Technology Association
DIN: Deutsches Institut fuer Normung (German Institute for Standardization)
ASTM: American Society for Testing and Materials; now ASTM International
SECS/GEM SEMI Equipment Communication Standard/Generic Equipment Model
ITRS: International Technology Roadmap for Semiconductors
Figure 1 – Committee Membership in the SEMI International Standards Program January 2006

Committee Membership by Voting Status

Figure 2 - Excerpt of SEMI 300mm Standards Usage Survey 2004

Has the Availability of 300 mm Standards Increased or Decreased Your Use of SEMI Standards Over the Last Four Years?

- Increase 62%
- Decrease 4%
- No change 25%
- No answer at all 9%

85 responses