SEMI Standardization Efforts in Compound Semiconductors

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ABSTRACT

The history and purpose of the SEMI Standards organization is presented with emphasis on the applications to the Compound Semiconductor Industry. A description of the processes used to develop a SEMI Standard, the consensus balloting procedure, and formal Standards publication is explained. Current standards development activities in the Compound Semiconductor Committee including work on GaAs, InP, SiC, electrical properties and proposed task forces are reviewed.

INTRODUCTION

SEMI (Semiconductor Equipment and Materials International) is a volunteer-driven organization for the exchange of information among suppliers and users of the semiconductor industry. Over 1,300 technologists worldwide, representing device manufacturers, equipment and materials suppliers, participate in the development of specifications and other standards for the semiconductor and flat panel display industries. Standards ensure compatibility of goods and services and help to establish the future direction of the industry. SEMI meetings provide an opportunity for industry representatives to participate in state-of-the-art technical discussions. By participating in SEMI, volunteers and companies can influence these important industry trends and directions.(Fig. 1)

Figure 1 Objectives of the SEMI standardization process.

BACKGROUND AND ORGANIZATIONAL HISTORY

SEMI was founded in the early 1970's as a trade show organization. It is still probably most well known for the SEMICON events now held in the US, Europe, Japan, and Taiwan. In the formative years the need for standardization in the fledgling silicon industry was realized. The idea to create a standards organization was conceived to resolve the differences in the many different specifications for silicon wafers, and to provide a forum where the equipment vendors, the wafer manufacturers, and device fabrication facilities could describe the properties and characteristics of their item of commonality: the silicon wafer. It was reported that in 1972 there were more than 2000 different specifications for silicon wafers.

At that point it was realized that some form of standardization was necessary to benefit all; the equipment suppliers, wafer producers and users. (Figure 2) In 1973 the SEMI Standards organization was formed, and in 1978 the first "Book of SEMI Standards" was published. At that time the semiconductor industry was U.S. based and so was SEMI. As the semiconductor industry expanded, the SEMI organization became international. Although headquartered in the U.S. , SEMI has offices and organizations in Europe, Japan, Taiwan, China, Korea, Singapore and Moscow. In addition, the scope of SEMI Standards has grown beyond the silicon wafer, to a number of committees: Compound Semiconductors, chemicals, testing, assembly, facilities, lithography, metrics, safety, MEMS, and flat panel displays. Electronics has changed the publication process. The standards that were previously published annually as a paper publication, are now published three times per year in CD-ROM format and on the Web.

Figure 2 Individuals and their organizations obtain value and economic benefit by participating in the standards organization.

STANDARDS DEVELOPMENT PROCESS

The activities and standards development within the committees are accomplished through volunteers organized into small working groups called Task Forces (TF). While the standards committee meets only two or three times each year to review progress and act on formal balloting, the Task Forces "meet" much more often. They may conduct their committee work through face to face traditional meetings, but most of the work is accomplished through teleconference meetings and e-mail to save time and travel costs.

When a need to develop a new standard is realized, a task force is proposed. The TF formally defines the charter, scope, membership, expected result and prescribes a timetable for the task force activity. The goal is to develop standards that are timely, technically accurate, and used by the industry.

Each task force is chartered to develop SEMI documents which may take the form of a Specification, but also may be a: Guideline, Terminology Definition, Procedure or Test Method. These documents have a lengthy review process and are approved by industry consensus. They are developed by volunteers and adherence to the specifications is entirely voluntary.

STANDARDS BALLOTING AND APPROVAL PROCESS

After task force and committee discussions, the proposed standards document is formally accepted by the committee for consensus balloting. All standards are voted and approved by the global committee members. Balloting is electronic, accomplished through the SEMI web site where each committee member is requested (encouraged) to vote. Each negative vote must include an explanation of the reasons for the rejection. Upon completion of the voting process, any negative votes are addressed. Specifically the negative is presented and discussed in the committee, at an open forum, where the voter is invited to attend and present any additional materials pertinent to the discussion. If any one negative vote is determined to be both related to the ballot item, and considered by the committee to be technically persuasive, the document is returned to the task force for review and revision. If there are no negative votes or all of the negatives are addressed and resolved in the committee, the ballot passes. The document is then sent for procedural review, formatting and eventual publication as a SEMI standard in CD-ROM and Web format. Once approved and published, the document is required to be reviewed and re-balloted every 5 years to assure the document remains current.

COMPOUND SEMICONDUCTOR MATERIALS COMMITTEE

The Compound Semiconductor Materials Committee, (CS) (which was originally named GaAs Materials Committee), was formed in the early 1980's from what was then the Materials committee. Silicon and GaAs had very different issues and needs for standardization, so separate Silicon Wafer and Compound Semiconductor Committees were organized. The GaAs committee quickly developed globally with participants forming committees and active task forces in Europe and Japan. Now the Compound Semiconductor Global Committee's focus areas have expanded beyond the group III-V compounds to SiC and II-VI compound semiconductors.

Currently the Compound Semiconductor Materials Committee is organized as a global committee. (Table 1. & Fig. 3) Each region: North America, Europe and Japan has locally organized CS committees with committee co-chairs and appropriate task force leaders. Some of the task forces exist in each region and are formed into global taskforces (e.g. SiC) while other tasks are handled by just one region.(e.g. Surface Flatness in Japan, or EL2 Test Method in Europe). Whether the task force is regional or global, technical input and meeting attendance from members from all regions is encouraged. All balloting is conducted globally.

Table 1. Breakdown of CS Materials Committee membership by region and membership status. World total may not be the sum of the regions because of duplicate membership or registration.

Table 1. Compound Semiconductor Committee Participants

	Region				
	Asia	**Europe**	**Japan**	**N. America**	**World Total**
Registered Participants	32	38	44	61	175
Different Companies Represented	26	33	38	53	145
Voting Members	6	14	14	19	53
Non-Voting Members	26	24	30	42	122
Suppliers of Materials and Equipment	2	13	12	15	42
Users	9	6	3	8	26
General Interest	21	19	29	38	107

ACTIVE NORTH AMERICAN TASK FORCE PROGRAMS

The North American Compound Semiconductor Materials Committee currently is organized into four task forces. (Fig. 3) The Electrical Properties task force works closely with the ASTM International (American Society for Testing and Materials) Compound Semiconductor Subcommittee F1.15 in developing test methods for semiconductors. Recently the silicon related test methods were transferred from ASTM to the SEMI organization but the Compound Semiconductor test methods remain within ASTM. The North American committee is working on procedures for non-destructive measurement of mobility in III-V, pHEMT epitaxial materials of InGaAs and GaN as well as methods to compare micropipe counting techniques in SiC. Currently the committee is conducting a round robin sample exchange comparing non-destructive and destructive methods of micropipe counting techniques and has published initial results [2]. The European CS Materials committee is reviewing a ballot concerning EL-2 measurements in GaAs.

The Indium Phosphide task force is revising a laser marking document to include identification of dopants used in InP. This work is coordinated with the SEMI committee on Traceability.

The GaAs task force is conducting the required 5 year review and update of the major specification document for GaAs. Additional re-approval of other GaAs related documents is organized by the Japanese committee. The possibility of combining a number of the older specifications during this update process is under consideration.

SiC is rapidly becoming the largest and most active task force. This task force is organized globally with contributors from North America, Europe, and Japan. Specifications for 2 and 3-inch wafers were approved and a 100mm SiC wafer specification is under ballot review. To identify future task force activities, several surveys of wafer suppliers and users were conducted within the past few months. Results have been used to prioritize activities. Plans include a round robin measurement of high resistivity SiC, and compiling nomenclature catalog of defects in SiC substrates and epitaxy. With the increase in SiC wafer size and the

influx of many new vendors and users, this area is moving from a material dominated by one supplier to an area where industry consensus standardization is required.

EUROPE AND JAPAN - TASK FORCES

CS Committees in Europe and Japan also have active task forces involved in compound semiconductors. In addition to the above noted work in North America, the European Committee has a number of task forces devoted to measurement techniques of resistivity, mobility, EL-2, and x-ray diffraction and active wafer task forces for GaSb and 200mm diameter GaAs. Work in Japan includes the required 5-year review of the GaAs documents, measurement of wafer surface flatness along with requirements for sapphire substrates.

SUMMARY

This paper discusses the SEMI Standards organization, the reasons for and advantages of participating in the standards development process. A description of the various Compound Semiconductor task force organizations, projects and developing standards for compound semiconductors is presented. Requests for additional information, suggestions of standards activities, or to volunteer for committee participation may be obtained through the SEMI website (www.semi.org) under the heading "STANDARDS". Additional information may be obtained by contacting a SEMI staff member [3] or one of the regional chairs or task force leaders.

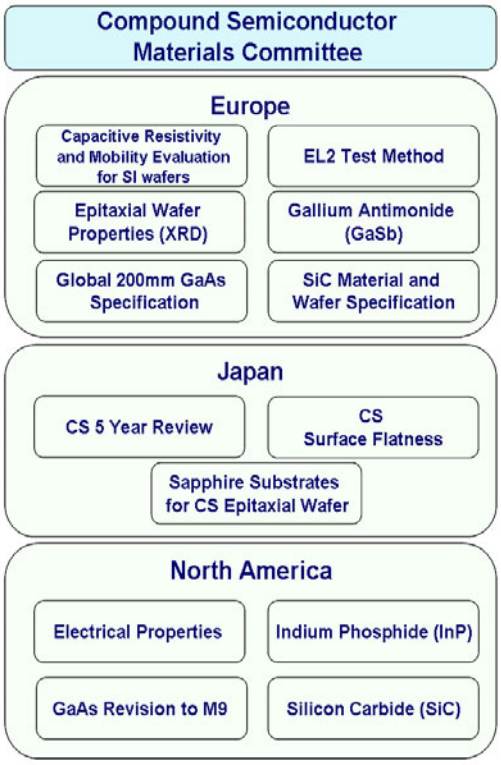

Figure 3 The Compound Semiconductor Materials Committee is organized globally with task forces in each of the three active regions.

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