

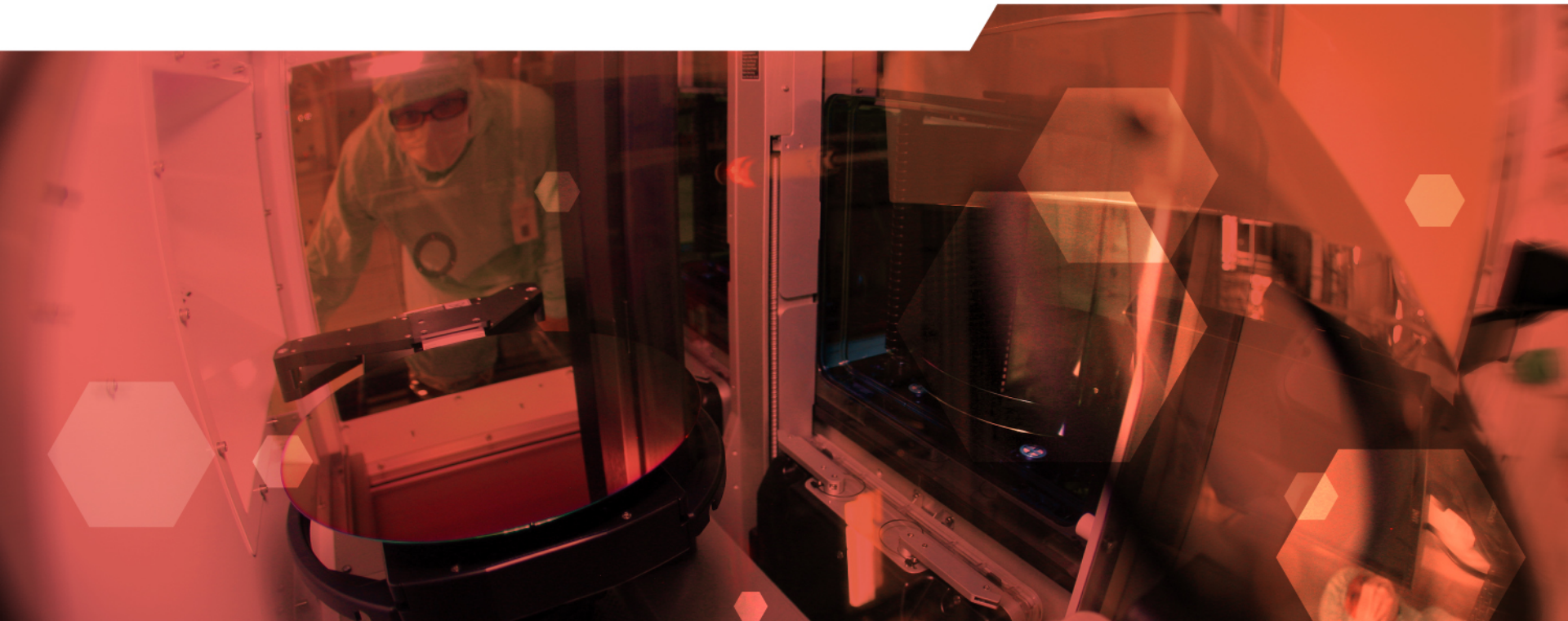
Electron Microscopy Workflow Taskforce

PIC TC update

July 10, 2019

Troy Morrison

Thermo Fisher Scientific



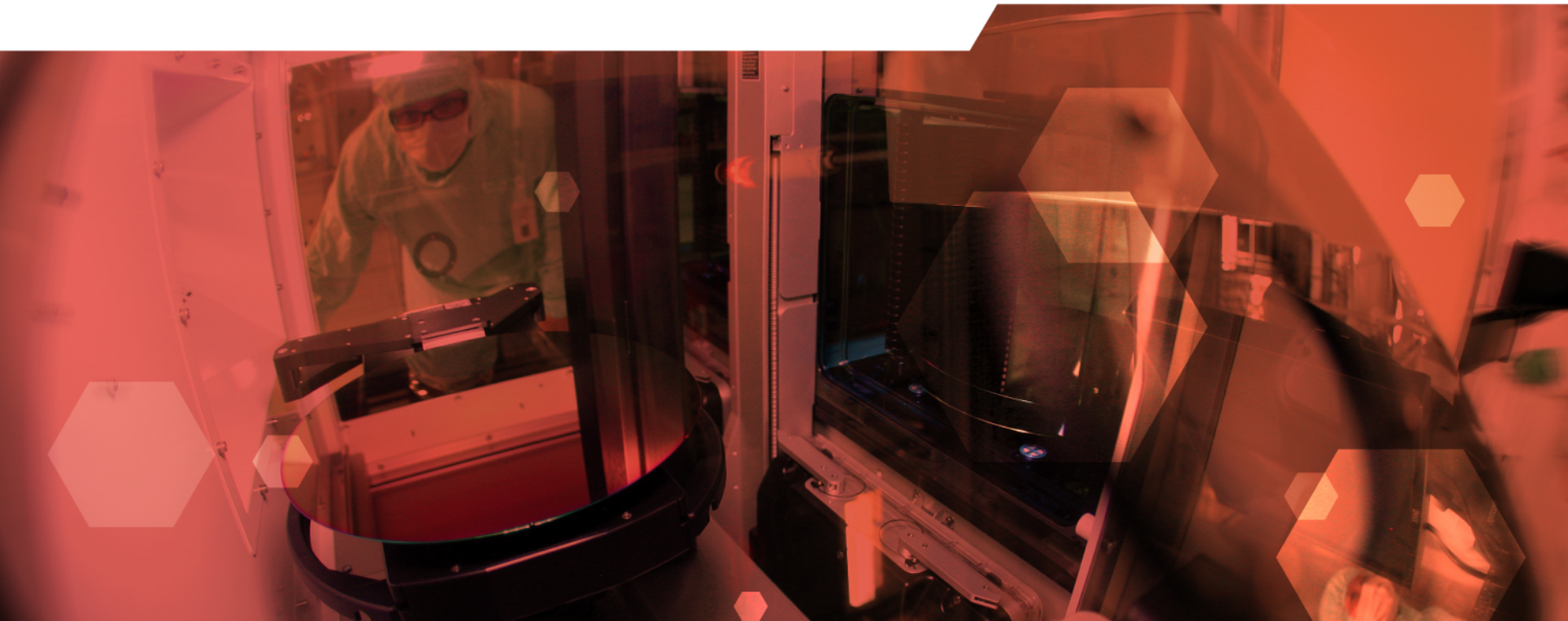
Agenda

- Ballot Results for document 6311A
- EM Workflow Taskforce: Next steps in standard creation

Doc 6311A Ballot Results and Responses

Peter Wagner

July 10, 2019



Ballot Result for Draft document 6311A

1. Doc. 6311A, New Standard: Specification for TEM Lamella Carrier Used in Electron Microscopy Workflows

1 As Cast Ballot Tally Summary For Document 6311A	
Return Percentage: 66.27%	TC Voting Interest Returns: 55 TC Voting Interest Distribution: 83
Total Voting Interests/Votes Received: 99/130	
Number of Accepts: 37 Accept %: 97.37%	Number of Rejects: 1
Total Comments: 3	Total Rejects: 1
Comment Issuer(s): Tsunobuchi, Hirokazu (Keyence) Onishi, Tsuyoshi (Hitachi Ltd) Asayama, Kyoichiro (JEOL)	Reject Issuer(s): Mashiro, Supika (TEL)

1. Negative by S. Mashiro, TEL(1)

- The usage of footnotes in section 7 is wrong and not in accordance with the Style Manual. As the footnote doesn't provide reference to outside SEMI material or trademark owner information. They should be expressed by using NOTE following each section needs an explanation by a description in NOTE.
- It seems the TF leader/author confuse the requirement of using footnote in a Figure or Table.
- Please see following two slides before a detailed response. They are extracts from the style manual and from SEMI M1.

Negative by S. Mashiro, TEL(2)

SEMI Standards Style Manual Table 1

#	Format	Rule
1-18	<i>References to Source Material (e.g., Periodicals, Books, Articles, Proceedings, and Web sites)</i>	<p>(1) List titles and sources of periodicals, books, articles, proceedings, and Web sites cited in the text of the Standard or Safety Guideline as a footnote reference at the bottom of the page where the citation first appears.</p> <p>(2) Use bibliographic entries to reference books, articles, and proceedings.</p> <p>(3) Format: See #1-13 <i>Footnotes</i>.</p> <p>(4) When listing a Web site, reference the complete URL and hyperlink. 'Web site' does not precede the URL.</p> <p>Example:</p> <div>http://www.semi.org http://tf.nist.gov/timefreq/general/glossary.htm</div>

Negative by S. Mashiro, TEL(3)

- SEMI M1, Table 1
- Example of using footnotes in tables.

				wafer, [] per cm ²	
2-10 OTHER (as required)☐				☐	☐
☐	☐	☐	☐	☐	☐
☐	☐	☐	☐	☐	☐
☐	☐	☐	☐	☐	☐

#1 The nominal edge exclusion, *EE*, specifies the diameter of the FQA, which is given by the nominal diameter (see Item 2-6.1) minus $2EE$ (see Figure 1). This quantity provides a center referenced property. Although use of edge referenced properties is discouraged, some equipments and procedures are based on edge referenced dimensions. When this occurs, the quality area is not fixed and some part of the FQA may fall outside the evaluated area, which is generally not a desirable situation.¶

#2 If specified as polished, this term is meant to imply a surface condition and not a particular processing technique. If desired, a quantitative measure of surface finish may optionally be indicated by specifying the *rms microroughness* over a specified spatial frequency (or wavelength) range. Because a standardized test method has not yet been developed for this metric, both values and test procedures, including sampling plan and detrending procedures, shall be agreed upon between supplier and customer.¶

#3 Note that in the case of {100} *n*-type wafers, 125 mm or smaller in diameter, with a secondary flat (Categories 1.1, 1.2, 1.5, 1.6, and 1.7), the primary and secondary flats are opposing and the concept of flat diameter does not apply because the diameter perpendicular to the flats does not intersect the wafer circumference.¶

SEMI M1-0918 © SEMI 1978, 2018

16

¶



#4 Thickness reported by parameter based edge profile measurement is typically different from the actual wafer thickness reported by standard dimensional metrology equipment used for flatness and shape. Users are cautioned not to assume the edge profile reported thickness is a valid wafer dimension.¶

#5 Flatness Acronyms are defined in the Flatness Decision Tree in Appendix 1.¶

#6 In today's technology, it may be possible to inspect for some of these items using automated surface scanning inspection systems (SSIS). Such systems should be calibrated according to SEMI M53 using polystyrene latex spheres deposited in accordance with SEMI M58. Some indication of the defects separable by such instruments is provided in SEMI M35; however, a standard test procedure has yet to be developed. Application of automated inspection with the use of an SSIS must be agreed upon between supplier and customer.¶

¶

Negative by S. Mashiro, TEL(4)

- Response:
 - The style manual states that references to source material such as books, articles, etc. should be listed in footnotes.
 - It does not state the opposite that footnotes can be used only for references to source material.
 - There are a multitude of examples where footnotes are used in the same way as in doc 6311A, Table 1 (e.g. in SEMI M1, Table 1).
 - Footnotes at Table 1 were already present in doc 6311 and were not objected.
 - NOTES cannot be used here. NOTES are used only for clarification and are not part of the standard whereas the footnotes here are essential for correctly using Table 1.

Negative by S. Mashiro, TEL(5)

- Taskforce Recommendation (unanimous hand vote)
 - Ask S. Mashiro to withdraw her negative.
 - If the negative is not withdrawn then consider this negative to be technically non-persuasive

Motion by Larry

The negative is related and not technically persuasive because the issue can be resolved by an editorial change.

Second by: Alan

11-0 / Motion passes.

From: Section 7.1

- 2-1.1 Manufacturing Method
- 2-1.2 Form Factor
- 2-2.5 Thickness
- 2-2.7 Edge Profile
- 2-2.9 Grid Bar Width³
- 2-2.9 Grid Opening Width³
- 2-2.12 Number of Pins⁴
- 2-2.12 Distance of Pins from y-Axis⁴
- 2-2.13 Width of Pin⁴
- 2-2.13 Height of Pin⁴
- 2-2.16 Shape of the Pins
- 2-4.1 Material(s) of LC
- 2-5.1 Material of Film³
- 2-5.2 Thickness of Film³
- 2-5.4 Total Number of Defective Sites in Zones A, B and C³
- 2-5.5 Missing Film Area³
- 2-5.6 Surface Roughness³
- 2-6.1 Particulate Contamination⁴
- 2-6.2 Surface Roughness⁴
- 2-7.4 Face for the ID Mark
- 2-7.6 Side Length of Square Dot⁵
- 2-7.7 Depth of Dot⁵
- 2-7.8 Marking Quality⁵
- 2-7.9 Content of ID Mark

³ Applies only to grid LC

⁴ Applies only to half-moon LC

⁵ Either dot size and depth or marking quality shall be included in the purchase order.

This is a Draft Document of the SEMI International Standards program. No material on this page is to be reproduced or distributed without the prior written consent of SEMI. Permission is granted to reproduce and/or distribute this document, in whole or in part, only within the scope of activity. All other reproduction and/or distribution without the prior written consent of SEMI is prohibited.

To: Section 7.1

- 2-1.1 Manufacturing Method
- 2-1.2 Form Factor
- 2-2.5 Thickness
- 2-2.7 Edge Profile
- 2-2.9 Grid Bar Width³
- 2-2.9 Grid Opening Width³
- 2-2.12 Number of Pins⁴
- 2-2.12 Distance of Pins from y-Axis⁴
- 2-2.13 Width of Pin⁴
- 2-2.13 Height of Pin⁴
- 2-2.16 Shape of the Pins
- 2-4.1 Material(s) of LC
- 2-5.1 Material of Film³
- 2-5.2 Thickness of Film³
- 2-5.4 Total Number of Defective Sites in Zones A, B and C³
- 2-5.5 Missing Film Area³
- 2-5.6 Surface Roughness³
- 2-6.1 Particulate Contamination⁴
- 2-6.2 Surface Roughness⁴
- 2-7.4 Face for the ID Mark
- 2-7.6 Side Length of Square Dot⁵
- 2-7.7 Depth of Dot⁵
- 2-7.8 Marking Quality⁵
- 2-7.9 Content of ID Mark

³~~Applies only to grid LC~~

⁴~~Applies only to half-moon LC~~

⁵~~Either dot size and depth or marking quality shall be included in the purchase order.~~

This is a Draft Document of the SEMI International Standards program. No material on this page is to be construed as a standard. Permission is granted to reproduce and/or distribute this document, in whole or in part, only within the scope of SEMI activity. All other reproduction and/or distribution without the prior written consent of SEMI is prohibited.

Motion

- Motion by Larry
- To accept the editorial change as documented.
- Second by: Alan
- Discussion:
 - Motion is justified because the information is already contained in the acceptable Table Footnote(s).
- 11-0
- Motion passes

Comments by H. Tsunobuchi, Keyence, T. Onishi, Hitachi, K. Asayama, JEOL (1)

- I accept with comments for this SEMI draft document 6311A.
- Please refer attached file.
- We decide to accept this SEMI draft document 6311A.
- But there is more appropriate expression for some terms and items in '2 7 ID Marking'.
- We would like to expect that these items will be corrected.
- Please refer attached file.

Comments by H. Tsunobuchi, Keyence, T. Onishi, Hitachi, K. Asayama, JEOL (2)

Changes to 6311A as suggested by the voters:

This is not an exclusion zone.

This is not a measurement method

2-7. ID MARKING			
2-7.1	Type	2-dim square DMC Data Matrix (2D code)	ISO16022
2-7.3	Position	Distance from Chord: 25 µm	by mutual agreement
2-7.4	Face for ID Mark	(specify): Front Face [], Rear Face []	by mutual agreement
2-7.5	Dimensions of ID Mark Window Exclusion zone for ID Mark	Width = 680 µm Height = 680 µm	by mutual agreement
2-7.6	Side Length of Square Dot#3,#4	Target [] ± Tolerance [] µm	by mutual agreement
2-7.7	Dot Depth #3,#4	Target [] ± Tolerance [] µm	by mutual agreement
2-7.8	Marking Quality#4	Better than grade C according to ISO 29158	ISO 29158
2-7.9	Content of ID Mark	(specify according to ISO 16022, EGC200)	

Does not make sense.

A measurement method is needed here.

This needs to be specified!

#3 Target values aiming at a Mark Grade better than C according to ISO 29158
#4 Specify either according to lines 2-7.6 and 2-7.7 or according to line 2-7.8

Comments by H. Tsunobuchi, Keyence, T. Onishi, Hitachi, K. Asayama, JEOL (3)

- Response:

- Line 2-7.1: a measurement method for the type of ID mark does not make sense. If wanted add “(ISO 16022)” editorially in the specification column. ISO 16022 is a specification.
- Line 2-7.4: a measurement method for the face of the LC where the ID mark should be put does not make sense. In the check boxes the customer can specify the face.
- Line 2-7.5: an “exclusion zone” is exempted from specifications. That’s not the case here. If “window” is not accepted then “mark field” might be an alternative. “Window” is used in other SEMI standards, e.g. in SEMI M12.

character window	the rectangular window within which all characters must be contained.	SEMI M12
------------------	---	----------

- Line 2-7.5: A measurement method needs to be agreed upon as values are specified here.
- Line 2-7.9: should not be removed. The content of the ID mark needs to be specified by customer, see § 8.1.4.7.

Comments by H. Tsunobuchi, Keyence, T. Onishi, Hitachi, K. Asayama, JEOL (4)

- Taskforce Recommendation (unanimous hand vote)
 - Line 2-7.5: Change from ‘Dimension of ID mark ‘window’ to ‘field’
- Motion by Peter

I move not to follow the comments with the exception of the editorial change of the term “ID Mark Window” to “ID Mark Field”.

Change from ‘Dimension of ID mark ‘window’ to ‘field’ throughout the document.

- Second by Larry

Discussion:

“Mark Field” is defined in the COT.

Figures 1 and 4 need to be changed.

Safety Check

☐ **This is not a Safety Document**, when all safety-related information is removed, the Document is still technically sound and complete.
(*Regulations* ¶ 8.7.1)

- Motion by: Troy
- 2nd by: **Alan**
- Discussion: None
- Tally: 9-0
- **Motion passed.**

IP Check

The TC Chapter meeting chair asked those participating, if they were aware of any patented technology that might be relevant (see *Regulations* ¶ 16.3.1.1) to the Standard or Safety Guideline; or, any copyrighted items or trademarks that are used/reproduced (see *Regulations* ¶ 16.4.1.2) in the Standard or Safety Guideline. (Also see, *Regulations* § 8.8)

☐ X The question is NOT answered in affirmative (No potentially material patented technology or use/reproduction of copyrighted items/trademarks is known.) **No motion needed**

☒ ~~The question is answered in affirmative.~~

~~• See A&R form for further action.~~



Microsoft Word
Document

Action for Document Passing TC Review

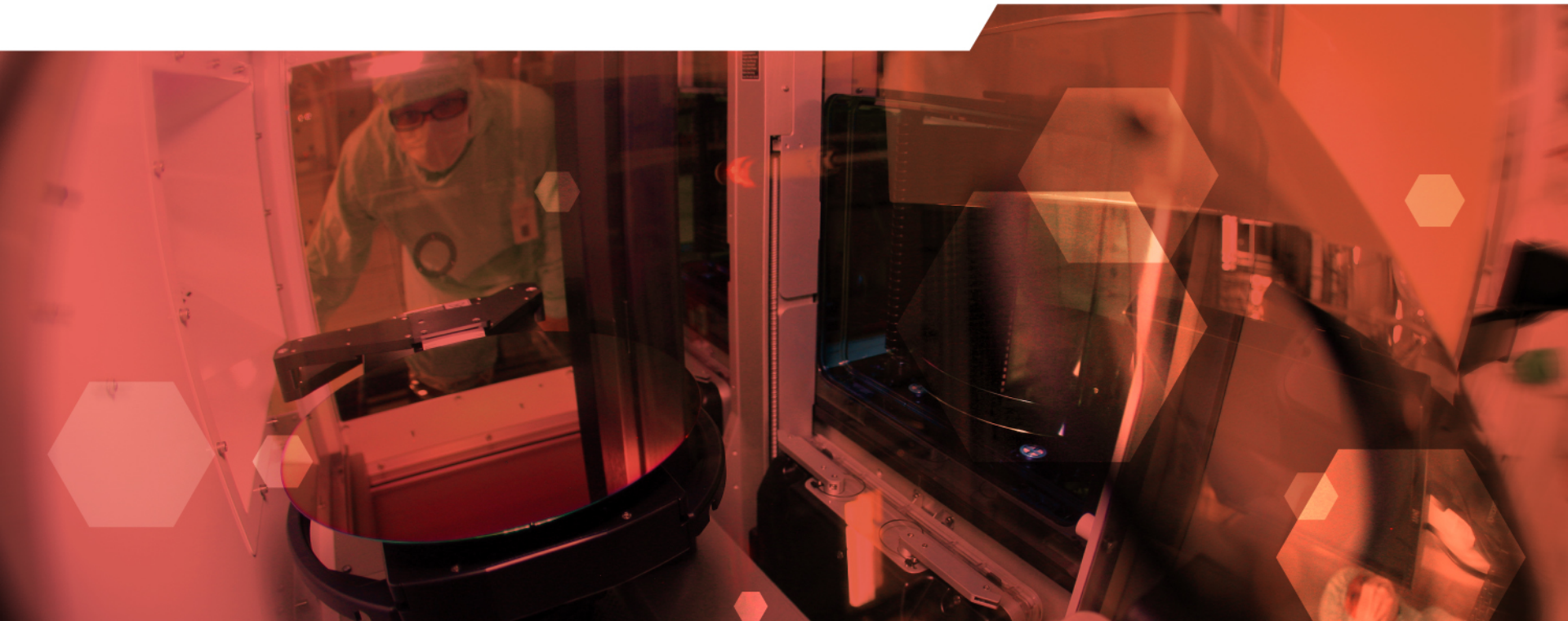
❑ This Document passed TC Chapter review with editorial changes and will be forwarded to the ISC A&R SC for procedural review.

- Motion by: Alan
- 2nd by: **Troy**
- Discussion: None
- Tally: 9-0
- **Motion passed.**

TEM Workflow Taskforce: what will be the focus of next phase activities?

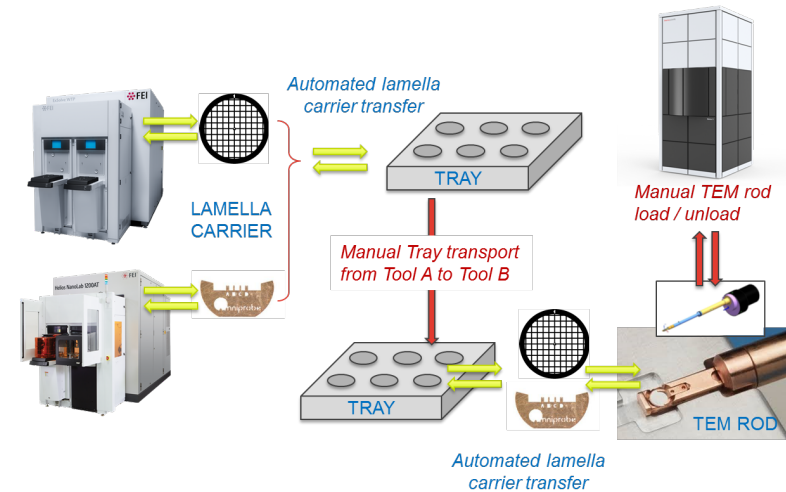
Laurens Kwakman

ThermoFisher Scientific



A recap of the Automated TEM workflow

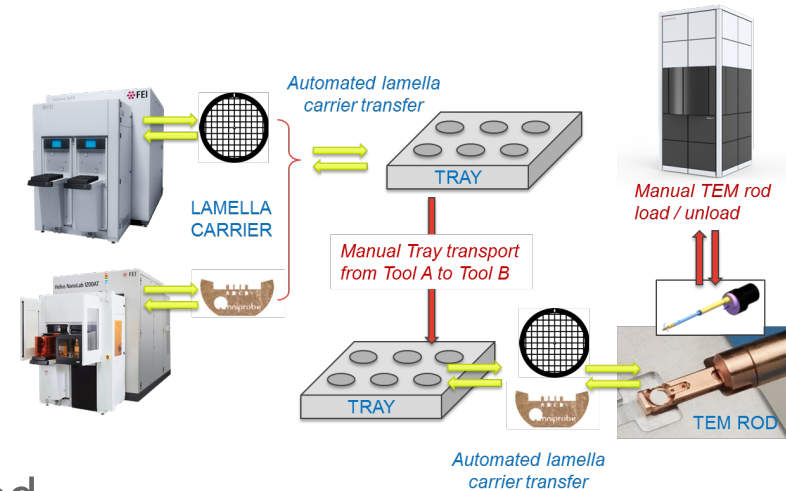
- The TEM lamella carrier is the support vehicle for TEM samples (lamellas) that are processed in the different systems that are part of the TEM workflow
 - FIB/SEM for sample preparation and extraction from wafer
 - TEM for sample analysis
 - Plasma cleaner for sample cleaning (optional)
- The TEM lamella carrier needs to be transported between the different systems that are part of the TEM workflow
 - This long distance transport requires the use of a mechanical support for the TEM lamella carrier(s): the lamella carrier (LC) “container”
- Phase 1 workflow automation requires a clear definition (SEMI Standard) for the lamella carrier and lamella carrier “container”



Phase 1 workflow automation

Rational for a SEMI Standard for LC container

- Automation efforts for lamella carrier transport at tool level require a well defined LC container, that is standardized to allow that lamella carriers can be transported between different types of TEM workflow tools from different suppliers
 - Analogy with wafer handling: if TEM lamella carrier = Silicon wafer, then the LC container = FOUP
 - At (FIB/TEM/auxiliary) tool level a LC container load station is needed
 - At (FIB/TEM/auxiliary) tool level a tool specific front-end module is needed to transfer LCs from the LC container into the tool specific LC holders (e.g. the TEM-rod at the TEM side)



Next steps

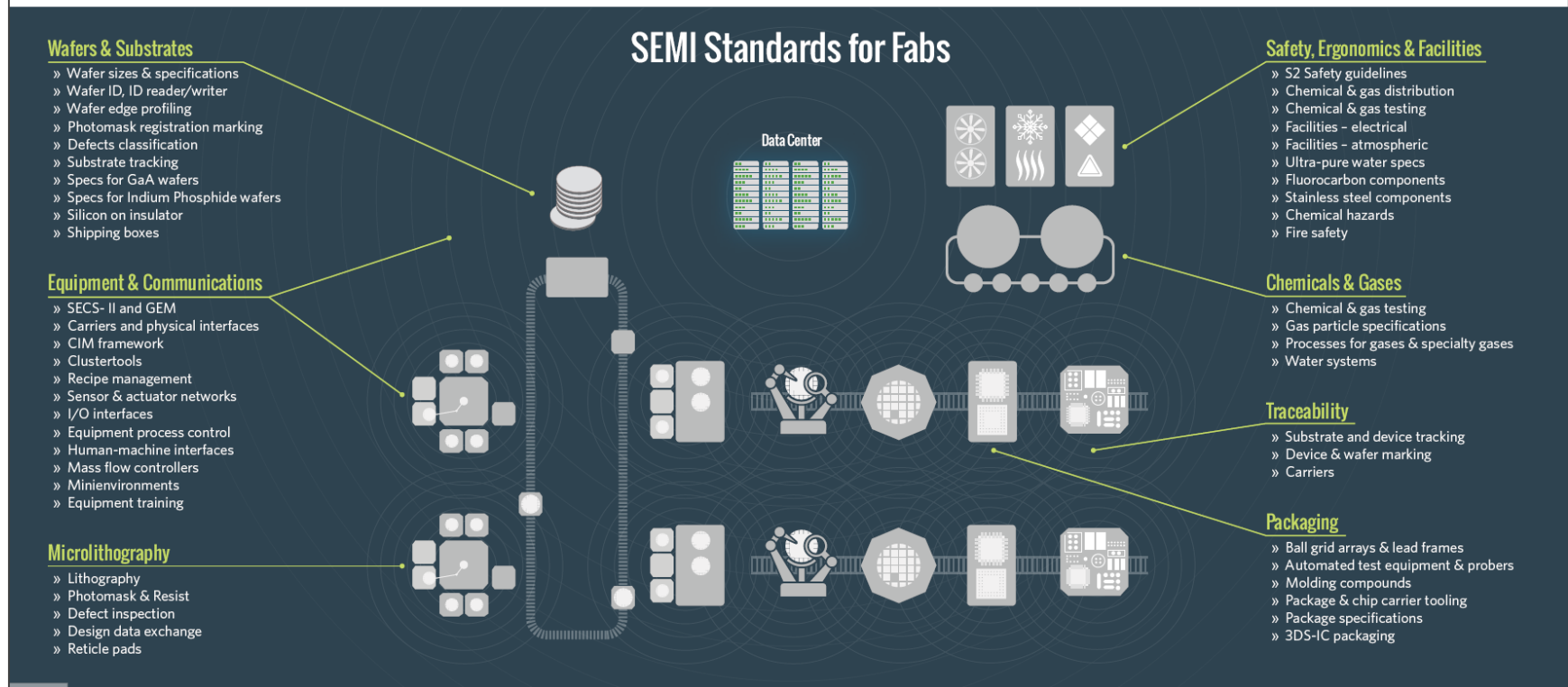
- Obtain consensus at Taskforce level about the next TF activities beyond the LC specifications (doc 6311A)
 - A new LC container SEMI Standard
 - Any other standardization activities?
- Formalize the new TF activities in a new SNARF document
 - Prepare a new SNARF document for the new TF activities
 - Review SNARF document with the Task force members
 - Have the new SNARF document approved by TC

- Back Up material

But, what more SEMI Standards may be required...

- As a source for inspiration:

SEMI STANDARDS ARE THE OXYGEN FOR THE INDUSTRY



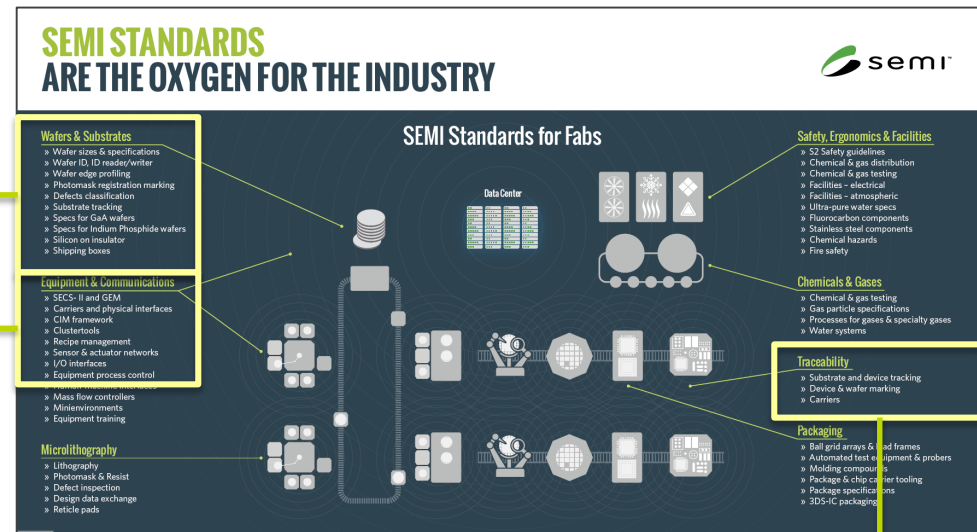
But, what more SEMI Standards may be required...

- As a source for inspiration:

- LC ID, ID reader/writer
- LC tracking
- LC shipping boxes

- SECS-II & GEM
- Physical interfaces
- I/O interfaces

- Traceability
- LC marking
- LC container marking



A Roadmap proposal for the Taskforce charter in 2019

- Continue TF collaborations to generate a new Standard specification for the Lamella Carrier Container (“LC container”) in a similar way as the LC Standard document was created:
 - Have a series of stakeholders presentations, outlining the relevant criteria and specifics from the stakeholder’s perspective
 - write a first draft specification document based on the initial consensus
 - Allow sufficient iterations to properly integrate all relevant aspects and detailed inputs from the various stakeholders
 - Objective: have a Specification Document ready for ballot by end 2019
- Start in parallel with an inventory of additional requirements:
 - While LC ID marking is defined in Doc 6311, one has to agree on ID marking conventions: how do end-users prefer to implement traceability?
 - What are the required data streams in the workflow? Between tools and between tools and FAB host systems
 - Any other suggested topics...

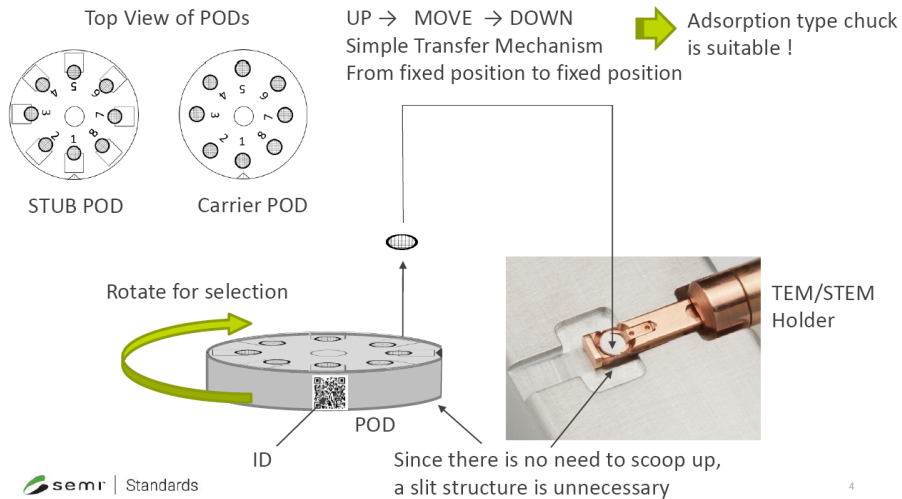
First considerations for LC container standard

- What is preferred form factor:
 - Round, rectangular, height, typical dimensions
- What are preferred container materials:
 - Anti-statics, dielectric vs. metallic, mechanical stability,...
- What will be the maximum LC positions in the container
- How will the LC be secured in the container against loss
 - Closing Lid, open/close mechanisms,...
- What are the required functionalities that relate to the container:
 - LC pick-up and drop-off
 - LC fiducials read-out, LC ID mark read-out
- LC container vs LC shipping box for initial delivery from grid suppliers
 - Requirements for LC transfer from shipping box to LC container
 - Can both be the same...
- Vacuum based LC pick and place.

Initial container proposals from Japanese Taskforce members

Consideration of the TEM Lamella Carrier transport system

- Disk type Carrier storage POD
- Carrier transportation using adsorption mechanism



Consideration of the TEM Lamella Carrier transport system

- Read ID mark from back side
- Adsorb the surface and carry the Carrier

TEM Lamella Carriers and pods are managed with unique numbers.

