SEMI E177-0919[E]
SPECIFICATION FOR TRANSMISSION ELECTRON MICROSCOPE (TEM) LAMELLA CARRIERS USED IN ELECTRON MICROSCOPY WORKFLOWS

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[E] This Standard was editorially modified to make corrections that were approved outside of the normal balloting process.

1 Purpose

1.1 Transmission electron microscopes (TEM) are widely used in semiconductor industry for process control, defect analysis and technology development support as the dimensions and details of the features to be investigated are well below the resolution of light microscopes and often also of scanning electron microscopes (SEM).

1.2 To enable inspection of the interesting parts of wafers or devices with TEM, small and thin samples—called lamellas—are prepared from the bulk of the wafer.

1.3 These very thin and fragile lamellas have to be mechanically/physically supported for transporting them to the transmission electron microscope and for manipulating them in the microscope for further investigation.

1.4 This physical support is provided by means of lamella carriers (LCs).

1.5 Standardization of the LCs is required for enabling a fully automated workflow from lamella preparation to investigation in the TEM and for allowing the users flexibility in selecting the tools and handling devices used in the workflow.

2 Scope

2.1 This Specification covers the form factor and the geometrical dimensions of LCs.

2.2 It also specifies physical and chemical features related to the utilization, handling, transport, storage and identification of the LCs.

2.3 This Specification is applicable to LCs used for TEM workflows in high volume manufacturing (HVM) as well as in laboratory environments.

2.4 This Specification defines two different kind of LCs, so-called grid LCs and half-moon LCs.

NOTICE: SEMI Standards and Safety Guidelines do not purport to address all safety issues associated with their use. It is the responsibility of the users of the Documents to establish appropriate safety and health practices, and determine the applicability of regulatory or other limitations prior to use.

3 Limitations

3.1 None.

4 Referenced Standards and Documents

4.1 *ISO Standards*[1]

ISO/IEC 16022 — Data Matrix Bar Code Symbology Specification

ISO/IEC 29158 — Direct Part Mark (DPM) Quality Guideline

NOTICE: Unless otherwise indicated, all documents cited shall be the latest published versions.

[1] International Organization for Standardization, ISO Central Secretariat, BIBC II, Chemin de Blandonnet 8, CP 401, 1214 Vernier, Geneva, Switzerland; Telephone: +41.22.749.01.11, http://www.iso.org

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5 Terminology

5.1 *Abbreviations and Acronyms*

5.1.1 *DMC* — data matrix code

5.1.2 *HVM* — high volume manufacturing

5.1.3 *LC* — lamella carrier

5.1.4 *TEM* — transmission electron microscope

5.2 *Definitions*

5.2.1 *active area, of a LC* — a circular area inside the rim on a LC where lamellas can be placed.

5.2.2 *edge exclusion zone, on a LC* — a narrow band on the LC surface, located just inside the edge of the rim, over which the values of the specified negative tolerances of the thickness do not apply.

5.2.3 *grid LC* — an LC consisting of a circle segment and a mesh/grid surrounded by a circular rim and covered by a very thin film typically consisting of carbon.

5.2.4 *half-moon LC* — an LC consisting of a circle segment from which pins protrude to which the lamellas can be fixed and surrounded by a rim that is about ⅔–½ of a circular annulus.

5.2.5 *lamella* — a piece of material with dimensions in the sub-millimeter range prepared from bulk material for investigation in a TEM.

5.2.6 *lamella carrier (LC)* — a device for supporting and holding one or multiple lamella(s).

5.2.7 *local slope, of film on grid LC* — the slope of the film across a site.

5.2.8 *site, of the grid LC* — an opening of the grid covered by a film where lamellas are placed.

5.2.9 *site, defective* — a site not conforming with the specification.

5.2.10 *warp, of grid LC* — the maximum height deviation of the LC front face across the LC lying on a flat surface.

6 Test Methods

6.1 So far, no standardized test methods are available for measuring the characteristics of LCs. Customer and supplier shall mutually agree on the test methods to be used and note them in the purchase order. This is denoted in Table 1, Part 2 as ‘by mutual agreement’.

7 Ordering Information

7.1 Purchase orders for LCs furnished to this Specification shall include the following items. These items are indicated on the Lamella Carrier Specification Format for Order Entry shown in Table 1 with a ♦ symbol in the left-most column. The line numbers refer to the line numbers in Table 1, Part 2.

- 2-1.1 Manufacturing Method
- 2-1.2 Form Factor
- 2-2.5 Thickness
- 2-2.7 Edge Profile
- 2-2.9 Grid Bar Width
- 2-2.10 Grid Opening Width
- 2-2.12 Number of Pins
- 2-2.13 Distance of Pins from *y*-Axis
- 2-2.14 Width of Pin
- 2-2.15 Height of Pin

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- 2-2.16 Shape of Pins
- 2-3.1 Center Fiducial
- 2-4.1 Material(s)
- 2-5.1 Material of Film
- 2-5.2 Thickness of Film
- 2-5.4 Total Number of Defective Sites in Zones A, B, and C
- 2-5.5 Missing Film Area
- 2-5.6 Surface Roughness
- 2-5.7 Number of Holes per Site
- 2-5.8 Position of Holes on Site
- 2-5.9 Diameter of Holes
- 2-6.1 Particulate Contamination
- 2-6.2 Surface Roughness
- 2-7.3 Face for the ID Mark
- 2-7.5 Side Length of Square Dot
- 2-7.6 Depth of Dot
- 2-7.7 Marking Quality
- 2-7.8 Content of ID Mark

7.2 In addition, the purchase order shall indicate the test method to be used in evaluating each of those items for which alternate test procedures exist.

7.3 The following items shall also be included in the purchase order:

7.3.1 Lot acceptance procedures.

7.3.2 Certification (if required).

7.3.3 Packing and shipping container labeling requirements.

7.4 Finally, other characteristics may be specified in purchase orders for LCs.

7.4.1 These shall be selected from the other items listed in the Lamella Carrier Specification Format for Order Entry, Parts 1 and 2 (see Table 1).

7.4.1.1 The parameter values provided in the requirements in § 8 may be used to identify appropriate values in the specification without selecting a value for each line. However, even if these requirements table values are used, the desired test methodology must be selected in accordance with § 7.2.

7.4.2 It is essential that all choices for the items selected to be specified be made in order not to have unspecified parameters that would lead to surprises between supplier and customer.

7.4.3 The characteristics of the LCs and the corresponding labels used for them in the figures and in § 8 are listed in Table 2.

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Table 1 Lamella Carrier Specification Format for Order Entry, Parts 1 and 2

Part 1 General Information

ITEM	*INFORMATION*	*DATE*
Customer Name		
Purchase Order Number		
Line Number		
Item Number		
General Specification Number		
Revision Level		
Part Number/Revision		

Part 2 Lamella Carrier

ITEM			*SPECIFICATION*	*MEASUREMENT METHOD*
2-1. General Characteristics				
♦	2-1.1	Manufacturing Method	(specify): _____	
♦	2-1.2	Form Factor	[ ] Circle, [ ] Half-Moon	
2-2. Dimensional Characteristics				
	2-2.1	Outer Diameter	3.025 ± 0.025 mm	by mutual agreement
	2-2.2	Rim Width	0.525 ± 0.025 mm	by mutual agreement
	2-2.3	Rim Open Sector Angle[#2]	±82.5° with respect to the positive *x*-axis with a tolerance −0°/+1°	by mutual agreement
	2-2.4	Active Area Diameter	1.8 +0/−0.1 mm	by mutual agreement
♦	2-2.5	Thickness	(specify): Target [ ] ± 10%	by mutual agreement
	2-2.6	Warp	≤100 µm	by mutual agreement
♦	2-2.7	Edge Profile	(specify): _____	
	2-2.8	Edge Exclusion Zone Width	100 µm ± 10 µm	by mutual agreement
♦	2-2.9	Grid Bar Width[#1]	(specify): Target [ ] ± Tolerance [ ] µm	by mutual agreement
♦	2-2.10	Grid Opening Width[#1]	(specify): Target [ ] ± Tolerance [ ] µm	by mutual agreement
	2-2.11	Chord Distance	150 ± 25 µm	
♦	2-2.12	Number of Pins[#2]	(specify): _____	
♦	2-2.13	Distance of Pins from *y*-Axis[#2]	1. (specify): Target [ ] ± Tolerance [ ] µm 2. (specify): Target [ ] ± Tolerance [ ] µm 3. (specify): Target [ ] ± Tolerance [ ] µm 4. (specify): Target [ ] ± Tolerance [ ] µm 5. Add additional pin specifications if needed	by mutual agreement
♦	2-2.14	Width of Pins[#2]	(specify): Target [ ] ± Tolerance [ ] µm	by mutual agreement
♦	2-2.15	Height of Pins[#2]	(specify): Target [ ] ± Tolerance [ ] µm	by mutual agreement
♦	2-2.16	Shape of Pins[#2]	(specify): _____	
2-3. Fiducials				
♦	2-3.1	Center Fiducial[#1]	(specify): _____	
	2-3.2	Left Fiducial	Circle, Diameter 250 ± 20 µm, Center at $x = -1250 \pm 10$ µm and $y = -150$ µm ± 10 µm	by mutual agreement
	2-3.3	Right Fiducial	Triangle, Side Length 250 ± 20 µm, Basis Center at $x = 1250 \pm 10$ µm and $y = -150$ µm ± 10 µm Corner Radius ≤30 µm	by mutual agreement

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