

# SEMI 3D20-0921

## SPECIFICATION FOR PANEL CHARACTERISTICS FOR PANEL LEVEL PACKAGING (PLP) APPLICATIONS

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**NOTICE:** Paragraphs entitled ‘NOTE:’ are not an official part of this Standard or Safety Guideline and are not intended to modify or supersede the official Standard or Safety Guideline. These have been supplied by the global technical committee to enhance the usage of the Standard or Safety Guideline.

### 1 Purpose

1.1 Panel level packaging (PLP) is projected to become a critical packaging process. This Specification identifies the physical properties that must be specified for the semiconductor industry to produce an equipment set for successful implementation of PLP. Many of the applications for panel packaging lines include fan-out technology applications.

1.2 To permit common processing equipment, standardized panel (largest external) dimensions (whether with or without process carrier) are essential. As this technology has developed, numerous panel sizes, thickness, warpage, and mass are being investigated delaying the introduction of the technology and requiring customization of equipment and processes for each panel type.

### 2 Scope

2.1 This Specification focuses on panel (largest external) dimensions (with or without process carrier), panel thickness, warpage, and mass, for use in PLP applications.

2.1.1 The term panel is used to include panel (largest external) dimensions (with or without process carrier).

2.2 Other parameters are included as an Appendix to this Specification.

**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 This Specification does not constitute a complete set of panel characteristics for defining an equipment set for PLP implementation.

### 4 Referenced Standards and Documents

4.1 *SEMI Standards and Safety Guidelines*

SEMI 3D12 — Guide for Measuring Flatness and Shape of Low Stiffness Wafers

SEMI G83 — Specification for Bar Code Marking of Product Packages

SEMI M1 — Specification for Polished Single Crystal Silicon Wafers

SEMI M12 — Specification for Serial Alphanumeric Marking of the Front Surface of Wafers

SEMI T7 — Specification for Back Surface Marking of Double-Side Polished Wafers with a Two-Dimensional Matrix Code Symbol

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

### 5 Terminology

5.1 *Abbreviations and Acronyms*

5.1.1 *PLP* — panel level packaging

## 5.2 Definitions

5.2.1 *process carrier* — a device or material, usually Si, ceramic, glass, or metal, that provides temporary mechanical support to hold one or more panels during processing.

NOTE 1: In front end applications and most SEMI Standards, the term ‘carrier’ is understood to mean any cassette, box or pod that is used to transport and store substrates. In most back end or packaging applications, the same term ‘carrier’ is used to describe the material that provides temporary mechanical support for the substrate during processing. To minimize confusion, the term ‘process carrier’ is used in this Standard for the back-end application.

5.2.2 *panel* — the rectangular base material to implement panel level packaging processes.

5.2.3 *warp* — the difference between the most positive and most negative distances of the median surface of a free, unconstrained panel from a reference plane.

## 6 Requirements

6.1 Panel material purchased or fabricated according to this Specification shall have the largest external dimensions of:

- 510 mm ± 1.0 mm × 515 mm ± 1.0 mm;
- OR
- 600 mm ± 1.0 mm × 600 mm ± 1.0 mm.

Both dimensions are the largest external dimensions. In some cases, the dimensions include only a panel, in remaining cases the dimensions may include a (usually smaller) panel plus the process carrier.

6.2 Panel material purchased or fabricated according to this Specification shall conform to the values for thickness, warp, and mass as shown in Table 1.

**Table 1 Specification for Thickness, Warp, and Mass**

| <i>Panel Metric</i> | <i>510 mm × 515 mm panel</i>   | <i>600 mm × 600 mm panel</i>   |
|---------------------|--------------------------------|--------------------------------|
| Thickness           | Minimum 200 µm<br>Maximum 3 mm | Minimum 200 µm<br>Maximum 3 mm |
| Warp                | Maximum 6 mm                   | Maximum 7.2 mm                 |
| Mass                | Maximum 4 kg                   | Maximum 4 kg                   |

6.3 For conveyor based equipment where the panel moves through the equipment with a leading edge, the shorter edge of the panel (e.g., 510 mm) shall be the leading edge.

6.4 Additional panel properties are listed in Appendix 1. Many of these properties are process specific and may vary from customer to customer.

## 7 Test Methods

7.1 Measurements shall be made or certifiable to one of the SEMI, ASTM, JEITA, or JIS standard test methods and specified in the purchase order.

7.2 If several different standard test methods for an item are commonly used within a region, it is particularly important that the applicable method of test be identified in the purchase order.

7.3 If no method of test is specified in the purchase order and if standard test methods from different geographic regions are available, the default method shall be a method in common usage for the region of the purchaser of the panel.

7.4 If no standard test method for an item is available, the test procedure to be used must be agreed upon between supplier and customer.

## 8 Product Labeling

8.1 The panels supplied under these specifications shall be identified by appropriately labeling the outside of each box or other container and each subdivision thereof in which it may reasonably be expected that the panels will be stored prior to further processing. Identification shall include as a minimum the lot number. The lot number, either (1) assigned by the original manufacturer of the panels, or (2) assigned subsequent to manufacture but providing reference to the original lot number, shall provide easy access to information concerning the fabrication history of the particular panels in that lot. Such information shall be retained on file at the manufacturer's facility for at least one month after that particular lot has been accepted by the customer.

## 9 Package and Package Labeling

9.1 Special packing requirements shall be subject to agreement between the supplier and customer. Otherwise, all panels shall be handled, inspected, and packed in such a manner as to avoid chipping, scratches, and contamination and in accordance with the best industry practices to provide ample protection against damage during shipment. Packaging should conform to SEMI G83.

## APPENDIX 1

### PHYSICAL PROPERTIES OF PANEL MATERIALS

**NOTICE:** The material in this Appendix is an official part of SEMI 3D20 and was approved by full letter ballot procedures on April 30, 2021.

#### A1-1 Additional Physical Properties of Panels

A1-1.1 In the case of panels, there are numerous process flows, each of which has differing requirements for starting material. This specification covers several panel parameters recognized as the enabling parameters for a PLP ecosystem to develop. However, it is recognized that a complete specification requires many physical properties, along with test methods suitable for determining their magnitude. Therefore, Table A1-1, Parts 1 and 2, lists a number of parameters, some optional, that may be useful in implementing a PLP process.

**Table A1-1 Additional Physical Properties of Panels, 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 PANEL                                                                                                                                      |       |                                                       |                                                                                                                                                                                                                                                                                                                   |                    |
| ITEM                                                                                                                                              |       |                                                       | SPECIFICATION                                                                                                                                                                                                                                                                                                     | MEASUREMENT METHOD |
| 2-1 GENERAL CHARACTERISTICS (Note that ♦ indicates an item for which a value or range is specified in the Requirements section of this Standard.) |       |                                                       |                                                                                                                                                                                                                                                                                                                   |                    |
|                                                                                                                                                   | 2-1.1 | Type                                                  | <input type="checkbox"/> With Process Carrier<br><input type="checkbox"/> Without Process Carrier                                                                                                                                                                                                                 |                    |
|                                                                                                                                                   | 2-1.2 | Panel Material <sup>#1</sup>                          | <input type="checkbox"/> Epoxy (Laminate)<br><input type="checkbox"/> Core*<br><input type="checkbox"/> Coreless*<br><input type="checkbox"/> Epoxy (Molding Compound)<br><input type="checkbox"/> Glass, Non-Alkali<br><input type="checkbox"/> Glass, Alkali<br><input type="checkbox"/> Other (specify): _____ |                    |
|                                                                                                                                                   | 2-1.3 | Process Carrier Material, if applicable <sup>#1</sup> | <input type="checkbox"/> Glass, Non-Alkali<br><input type="checkbox"/> Glass, Alkali<br><input type="checkbox"/> Silicon<br><input type="checkbox"/> Ceramic<br><input type="checkbox"/> Metal (specify): _____<br><input type="checkbox"/> Other (specify): _____                                                |                    |
| 2-2 DIMENSIONAL CHARACTERISTICS                                                                                                                   |       |                                                       |                                                                                                                                                                                                                                                                                                                   |                    |
| ♦                                                                                                                                                 | 2-2.1 | Dimensions <sup>#1, #2</sup>                          | <input type="checkbox"/> 510 mm ± 1.0 mm × 515 mm ± 1.0 mm<br><input type="checkbox"/> 600 mm ± 1.0 mm × 600 mm ± 1.0 mm                                                                                                                                                                                          |                    |
| ♦                                                                                                                                                 | 2-2.2 | Minimum Thickness <sup>#1</sup>                       | <input type="checkbox"/> 200 μm<br><input type="checkbox"/> Value (specify): _____                                                                                                                                                                                                                                |                    |

| ITEM                                         |        |                                          | SPECIFICATION                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | MEASUREMENT METHOD |
|----------------------------------------------|--------|------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------|
| ◆                                            | 2-2.3  | Maximum Thickness <sup>#1</sup>          | <input type="checkbox"/> 3.0 mm<br><input type="checkbox"/> Value (specify): _____                                                                                                                                                                                                                                                                                                                                                                                               |                    |
|                                              | 2-2.4  | Rigidity                                 | Young's Modulus<br><input type="checkbox"/> Value (specify): _____<br>Other (specify): _____<br><input type="checkbox"/> Value (specify): _____                                                                                                                                                                                                                                                                                                                                  |                    |
| ◆                                            | 2-2.5  | Warp <sup>#3</sup>                       | <input type="checkbox"/> 6 mm (510 mm × 515 mm)<br><input type="checkbox"/> 7.2 mm (600 mm × 600 mm)<br><input type="checkbox"/> Value (specify): _____                                                                                                                                                                                                                                                                                                                          | SEMI 3D12          |
|                                              | 2-2.6  | Flatness, Global                         | Acronym: <sup>#4</sup> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> Value: <input type="checkbox"/> μm                                                                                                                                                                                                                                                                                           |                    |
|                                              | 2-2.7  | Flatness, Local                          | Acronym: <sup>#4</sup> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> Value: Not greater than <input type="checkbox"/> μm<br>Site Size _____ mm × _____ mm<br><input type="checkbox"/> % Usable Area _____<br><input type="checkbox"/> Include partial sites;<br><input type="checkbox"/> Do not include partial sites<br>Offset: x = <input type="checkbox"/> mm, y = <input type="checkbox"/> mm |                    |
|                                              | 2-2.8  | Edge Profile (horizontal, top edges)     | <input type="checkbox"/> Template Based<br><input type="checkbox"/> Profile Parameter Based                                                                                                                                                                                                                                                                                                                                                                                      | SEMI M1            |
|                                              | 2-2.9  | Edge Profile (horizontal, bottom edges)  | <input type="checkbox"/> Template Based<br><input type="checkbox"/> Profile Parameter Based                                                                                                                                                                                                                                                                                                                                                                                      | SEMI M1            |
|                                              | 2-2.10 | Edge Profile (vertical edges)            | <input type="checkbox"/> Template Based<br><input type="checkbox"/> Profile Parameter Based                                                                                                                                                                                                                                                                                                                                                                                      | SEMI M1            |
|                                              | 2-2.11 | Orientation                              | <input type="checkbox"/> Specify: _____                                                                                                                                                                                                                                                                                                                                                                                                                                          |                    |
|                                              | 2-2.12 | Total Thickness Variation                | <input type="checkbox"/> <input type="checkbox"/> μm, max.                                                                                                                                                                                                                                                                                                                                                                                                                       | SEMI 3D12          |
|                                              | 2-2.13 | Local Thickness Variation                | <input type="checkbox"/> <input type="checkbox"/> μm, max per <input type="checkbox"/> mm <sup>2</sup>                                                                                                                                                                                                                                                                                                                                                                           |                    |
| <b>2-3 OTHER CHARACTERISTICS</b>             |        |                                          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                    |
|                                              | 2-3.1  | Coefficient of Thermal Expansion at 22°C | <input type="checkbox"/> _____ ppm/K                                                                                                                                                                                                                                                                                                                                                                                                                                             |                    |
|                                              | 2-3.2  | Transmission                             | <input type="checkbox"/> Specify: _____                                                                                                                                                                                                                                                                                                                                                                                                                                          |                    |
| ◆                                            | 2-3.3  | Maximum Mass, Single Panel               | <input type="checkbox"/> 4 kg<br><input type="checkbox"/> Value (specify): _____                                                                                                                                                                                                                                                                                                                                                                                                 |                    |
|                                              | 2-3.4  | ID Marking                               | <input type="checkbox"/> SEMI T7<br><input type="checkbox"/> SEMI M12<br><input type="checkbox"/> Other (specify): _____                                                                                                                                                                                                                                                                                                                                                         |                    |
|                                              | 2-3.5  | ID Mark location                         | <input type="checkbox"/> Specify: _____                                                                                                                                                                                                                                                                                                                                                                                                                                          |                    |
| <b>2-4 PANEL PREPARATION CHARACTERISTICS</b> |        |                                          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                    |
|                                              | 2-4.1  | Hazardous Substances Restrictions        | Legislation: _____<br>(repeat for all legislations)                                                                                                                                                                                                                                                                                                                                                                                                                              |                    |

#1 The allowed combination of physical parameters may lead to mechanically unstable panels. A discussion of this may be found in Related Information 1.

#2 A discussion on how these two sizes were determined, as well as expectations of additional larger sizes in the future, may be found in Related Information 1.

#3 The Shape Decision Tree in Appendix 3 fully describes the various shape parameters that can be specified.

#4 Flatness Acronyms are defined in the Flatness Decision Tree in Appendix 2.

## A1-2 Parameters from Table A1-1

### A1-2.1 General Characteristics

A1-2.1.1 *Type* — The type indicates whether the material is provided as a panel or as a panel mounted on a process carrier.

A1-2.1.2 *Panel Material* — The panel material is that of the unprocessed panel.

A1-2.1.3 *Process Carrier Material* — Applicable only if the panel is delivered supported by a process carrier.

### A1-2.2 Dimensional Characteristics

A1-2.2.1 *Dimensions* — The dimensions are that of the panel, if the panel is provided unsupported. However, if the panel is provided supported on a process carrier, the dimensions are the outer dimensions of the combined pair.

A1-2.2.1.1 *Panel Dimensions (of Process Carrier Supported Panel)* — If the panel is provided supported on a process carrier, indicate the actual dimensions of the panel, which would be less than or equal to the overall dimensions.

A1-2.2.2 *Minimum Thickness* — The minimum thickness is the thickness of the panel, if the panel is unsupported. If the material is a panel supported on a process carrier, the minimum thickness is the combined thickness of the panel and its carrier.

A1-2.2.3 *Maximum Thickness* — The maximum thickness is the thickness of the panel, if the panel is unsupported. If the material is a panel supported on a process carrier, the maximum thickness is the combined thickness of the panel and its carrier.

A1-2.2.4 *Rigidity* — Young's modulus or other parameter describing the stiffness of the panel or combined panel/process carrier.

A1-2.2.5 *Warp* — The difference between the most positive and most negative distances of the median surface of a free, unclamped panel from a reference plane (it is assumed that warp includes sori, bow, and other forms of warp) (adapted from definition in SEMI 3D4).

A1-2.2.6 *Flatness* — The panels shall meet global and site flatness requirements as specified in the purchase order. Details of different flatness parameters are given in Appendix 1.

A1-2.2.7 *Edge Profile* — Panels contain twelve unique edges, of which eight are horizontal and can be separately specified as 'top' and 'bottom'. The remaining four edges are vertical and are at the corners of the panel; however, the corners themselves may be rounded. The definitions of the edges may either be Template Based or Profile Parameter Based as agreed upon by supplier and customer.

A1-2.2.8 *Orientation* — Orientation, including whether the smaller side of the panel (e.g., 510 mm or 600 mm) or the larger side of the panel (e.g., 515 mm or 600 mm) is at the leading edge when entering or exiting the equipment and/or location of ID marking relative, as agreed upon between supplier and customer.

A1-2.2.9 *Total Thickness Variation (TTV)* — TTV is the difference between the maximum and minimum values of the thickness of the panel and is measured at a set number of predetermined locations on the panel.

A1-2.2.10 *Local Thickness Variation* — Difference between the maximum and minimum thickness of the panel measured within a site. The value is assigned to the center of this region.

### A1-2.3 Other Characteristics

A1-2.3.1 *Coefficient of Thermal Expansion* — Value and range of validity shall be specified to avoid problems due to mismatch of thermal expansion between adjacent substrates.

A1-2.3.2 *Transmission* — Optical transmission will be based on optical wavelength and other parameters as agreed upon by supplier and customer.

A1-2.3.3 *Mass, Single Panel* — Mass is that of a single panel, for unsupported panel; it is the mass of the panel plus process carrier for a process carrier-supported panel.

A1-2.3.4 *ID Marking* — All panels shall be marked with a two-dimensional matrix code symbol on the back surface outside the fixed quality area in the manner specified in SEMI T7. This marking shall be done as soon as practical after manufacture in order to provide both identification and traceability of each panel.