

SEMI F19-0304 (Reapproved 0310)

SPECIFICATION FOR THE SURFACE CONDITION OF THE WETTED SURFACES OF STAINLESS STEEL COMPONENTS

This standard was technically approved by the global Gases Committee. This edition was approved for publication by the global Audits & Reviews Subcommittee on December 16, 2009. Initially available at www.semi.org February in 2010. Originally published in 1995; previously published March 2004.

NOTICE: This document was reapproved with editorial changes.

1 Purpose

1.1 The purpose of this specification is to provide a standard for the quality of the wetted surfaces of stainless steel components used in the chemical (gas and liquid) distribution systems of semiconductor manufacturing facilities.

2 Scope

2.1 This specification defines the wetted surface characterization requirements and the finish acceptance criteria for tubing and components fabricated in stainless steel per SEMI F20 and intended to control and/or contain gases and liquids used in semiconductor manufacturing.

2.2 The surface characterization tests to be performed are specified herein, and the existing standards for performing these tests are referenced.

2.3 Terms specific to this technology are either listed herein as they relate to the acceptance criteria of this specification or are defined in the referenced documents as they relate to a specific test method.

NOTICE: This standard does not purport to address safety issues, if any, associated with its use. It is the responsibility of the users of this standard to establish appropriate safety and health practices and determine the applicability of regulatory or other limitations prior to use.

3 Referenced Standards and Documents

3.1 SEMI Standards

SEMI F20 — Specification for 316L Stainless Steel Bar, Forgings, Extruded Shapes, Plate, and Tubing for Components Used in General Purpose, High Purity and Ultra-High Purity Semiconductor Manufacturing Applications

SEMI F37 — Method for Determination of Surface Roughness Parameters for Gas Distribution System Components

SEMI F60 — Test Method for ESCA Evaluation of Surface Composition of Wetted Surfaces of Passivated 316L Stainless Steel Components

SEMI F70 — Test Method for Determination of Particle Contribution of Gas Delivery System

SEMI F72 — Test Method for Auger Electron Spectroscopy (AES) Evaluation of Oxide Layer of Wetted Surfaces of Passivated 316L Stainless Steel Components

SEMI F73 — Test Method for Scanning Electron Microscopy (SEM) Evaluation of Wetted Surface Condition of Stainless Steel Components

SEMI F77 — Test Method for Electrochemical Critical Pitting Temperature Testing of Alloy Surfaces Used in Corrosive Gas Systems

3.2 ASTM Standard¹

ASTM A967 — Standard Specification for Chemical Passivation Treatments for Stainless Steel Parts

ASTM G150 — Standard Test Method for Electrochemical Critical Pitting Temperature Testing of Stainless Steels

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

4 Terminology

4.1 Abbreviations and Acronyms

- 4.1.1 $\text{\AA}$ — Angstrom (= 0.1 nm)
- 4.1.2 *AES* — Auger Electron Spectroscopy
- 4.1.3 *Avg* — Average
- 4.1.4 *CPT* — Critical Pitting Temperature
- 4.1.5 *Cr* — Chemical symbol for Chromium
- 4.1.6 *Cr/Fe* — Ratio of total Chromium to total Iron in the passive oxide layer [SEMI F60]
- 4.1.7 *CrOX* — Chromium Oxide
- 4.1.8 *CrOX/FeOX* — Ratio of Chromium Oxide to Iron Oxide in the passive oxide layer [SEMI F60]
- 4.1.9 *EDS* — Energy Dispersive X-ray Spectroscopy
- 4.1.10 *ESCA* — Electron Spectroscopy for Chemical Analysis (sometimes referred to as XPS)
- 4.1.11 *Fe* — Chemical symbol for Iron
- 4.1.12 *FeOX* — Iron Oxide
- 4.1.13 *Max* — Maximum
- 4.1.14 μin — Micro inch (= 10^{-6} inch)
- 4.1.15 μm — Micrometer (= 10^{-6} meter)
- 4.1.16 *nm* — Nanometer (= 10^{-9} meter)
- 4.1.17 *Ra* — Roughness average of surface profile
- 4.1.18 *Ry* — Maximum peak-to-valley roughness height of surface profile
- 4.1.19 *SEM* — Scanning Electron Microscopy
- 4.1.20 *XPS* — X-ray Photoelectron Spectroscopy (sometimes referred to as ESCA)

4.2 Definitions

- 4.2.1 *blistering* — a localized delamination within the metal that has an appearance of chipped or flaked-off areas.
- 4.2.2 *defect* — unintentional and undesirable irregularity in the part surface that could affect system performance. Examples of such defects include cracks, inclusions, blistering, dents, pits, stringers and scratches.
- 4.2.3 *dent* — an isolated irregularity on the wetted surface made by an impact.
- 4.2.4 *electropolishing* — a method of polishing metals and alloys in which material is removed from the surface by making the metal the anode in an electrolytic bath.
- 4.2.5 *flaw* — synonymous with defect.
- 4.2.6 *frostiness* — a continuous surface pattern whose appearance is like that of a sparkly, very fine, sandy-textured surface.
- 4.2.7 *grain boundary* — an interface separating two grains, where the orientation of the lattice changes from that of one grain to that of the other.
 - 4.2.7.1 *stepped grain boundary* — a form of preferential etching in which the grains are attacked at different rates, resulting in one grain to appear raised with respect to an adjacent grain, forming a “step” at the grain boundary.
- 4.2.8 *haze* — a diminished surface brightness or specularity attributable to diffuse light scattering by concentrations of microscopic surface irregularities, or to chemical inhomogeneity.

4.2.9 *inclusion* — indigenous or foreign material within the metal, usually referring to non-metallic compound particles such as oxides, alumina, sulfides or silicates.

4.2.10 *interrupted electropolishing* — a break in the continuity of the electropolished surface appearance due to a change of electropolishing conditions at the interruption boundary; may be visible as a change in reflectivity across the boundary or a step in the surface.

4.2.11 *lay* — the direction of the predominant surface pattern, ordinarily determined by the production method used.

4.2.12 *machining line* — a type of process line that results from machining processes.

4.2.13 *nominal surface* — the intended surface contour, the shape and extent of which is shown and dimensioned on a drawing or descriptive definition.

4.2.14 *orange peel* — large-featured, roughened type of surface visible to the unaided eye whose surface appearance pattern is like that of an orange peel.

4.2.15 *passivation* — the chemical treatment of a stainless steel surface with an oxidizing solution for the purpose of enhancing the corrosion resistant surface film.

4.2.16 *pit* — a surface cavity or crater with a defined edge not caused by impact.

4.2.17 *process lines* — surface features that are a result of the material removal or forming process used in manufacturing of a component.

4.2.18 *Ra Avg.* — average Ra of a set of surface roughness measurements.

4.2.19 *Ra Max.* — maximum Ra of a set of surface roughness measurements.

4.2.20 *Ry Max.* — maximum Ry of a set of surface roughness measurements.

4.2.21 *roughness* — the finer irregularities of the surface texture, usually including those irregularities that result from the manufacturing process. These are considered to include traverse feed marks and other irregularities within the limits of the roughness sampling length.

4.2.22 *scratch* — an elongated mark or groove cut in the surface by mechanical means, not associated with the predominant surface texture pattern.

4.2.23 *stringer* — a microstructural configuration of alloy constituents or foreign nonmetallic material, or trace thereof, oriented in the direction of mechanical working.

4.2.24 *surface texture* — the repetitive or random deviations from the nominal surface which form the three dimensional topography of the surface. Surface texture includes roughness, waviness, lay, and flaws.

4.2.25 *waviness* — the more widely spaced component of surface texture. Unless otherwise noted, waviness is to include all irregularities whose spacing is greater than the roughness sampling length. Waviness may result from such factors as machine or work deflections, vibrations, chatter, heat treatment, or warping strains. Roughness may be considered as superimposed on a “wavy” surface.

4.2.26 *wetted surface* — surfaces of the components that are in contact with the contained gases and/or liquids used in semiconductor manufacturing processes.

5 Ordering Information

5.1 The purchase order for components to be supplied in compliance with this specification shall include the following information:

5.1.1 Purchase Order Number.

5.1.2 Supplier's (preferred) or purchaser's part number(s), including size(s).

5.1.3 Quantity of components by part number and size.

5.1.4 Grade of each part number and size per the grade classifications specified in this specification.

5.1.5 Reference to this specification number and any additional applicable specifications.

5.1.6 Documentation and certification requirements.