

SEMI F19-95

SPECIFICATION FOR THE FINISH OF THE WETTED SURFACES OF ELECTROPOLISHED 316L STAINLESS STEEL COMPONENTS

1 Purpose

The purpose of this specification is to provide a standard for the quality of the internal (wetted) surfaces of electropolished 316L 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 electropolished 316L stainless steel components.

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 process.

3 Referenced Documents

3.1 SEMI Standards

SEMI F2 — Specification for 316L Stainless Steel Tubing for General Purpose Semiconductor Manufacturing Applications

SEMI F16 — Specification for 316L Stainless Steel Tubing Which Is to Be Finished and Electropolished for High Purity Semiconductor Manufacturing Applications

Doc. 2335¹ — Test Method for Determination of Surface Roughness by Contact Profilometry for Chemical Distribution System Components

Doc. 2336¹ — Test Method for Auger Electron Spectroscopy (AES) Analysis of Surface and Oxide Composition of Electropolished Stainless Steel Tubing for Chemical Distribution System Components

Doc. 2337¹ — Test Method for ESCA Analysis of Surface Composition and Chemistry of Electropolished

Stainless Steel Tubing for Chemical Distribution Systems Components

3.2 ANSI/ASME Standards²

B46.1 — Surface Texture: Surface Roughness, Waviness, and Lay

3.3 ASTM Standards³

A 182 — Specification for Forged or Rolled Alloy-Steel Pipe Flanges, Forged Fittings, and Valves and Parts for High Temperature Service

A 240 — Specification for Heat-Resisting Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels

A 269 — Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Service

A 276 — Specification for Stainless and Heat-Resisting Steel Bars and Shapes

A 479 — Specification for Stainless and Heat-Resisting Steel Wire, Bars, and Shapes for Use in Boilers and Other Pressure Vessels

A 632 — Specification for Seamless and Welded Austenitic Stainless Steel Tubing (Small Diameter) for General Service

F 1372 — Test Method for SEM Analysis of Metallic Surface Condition for Gas Distribution System Components

4 Terminology

4.1 Terms Defined in ANSI/ASME B46.1

4.1.1 *flaws* — Unintentional irregularities which occur at one place or at relatively infrequent or widely varying intervals on the surface. Flaws include such defects as cracks, blowholes, inclusions, checks, ridges, and scratches.

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

4.1.3 *measured surface* — A representation of the surface obtained by instrument or other means.

¹ Draft Documents 2335, 2336, and 2337 will be developed and balloted by the SEMI F&ESH Committee, using materials contributed by SEMATECH. The methods were written and developed by a SEMATECH-sponsored task force, validated by Research Triangle Institute, and subsequently published by SEMATECH as SEMASPEC's. The methods were also proposed, and then withdrawn, by ASTM Committee F1.10.

² American Society of Mechanical Engineers, United Engineering Center, 345 East 47th Street, New York, NY 10017

³ American Society for Testing and Materials, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959

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

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

4.1.6 *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.

4.1.7 *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 Additional Terms

4.2.1 *blistering* — A surface discontinuity whose appearance pattern is like that of orange peel with randomly chipped or flaked off areas.

4.2.2 *dent* — A protrusion on the wetted surface that can be associated with an irregularity on the external surface.

4.2.3 *frostiness* — A continuous surface discontinuity whose appearance pattern is like that of a sparkly, very fine, sandy-textured surface.

4.2.4 *haze* — The appearance of a localized diminishing in brightness or luster of a surface when compared to the adjacent surfaces.

4.2.5 *inclusion* — A piece of foreign material that is embedded in the surface and is visible to the unaided eye.

4.2.6 *orange peel* — A continuous surface discontinuity whose irregular surface appearance pattern is like that of an orange peel.

4.2.7 *pit or stringer (multiple pits)* — A small cavity or series of small cavities visible to the unaided eye.

4.2.8 *scratch* — An elongated mar in the surface, not associated with the predominant surface texture pattern, that is visible to the unaided eye.

5 General Requirements

Electropolished components furnished under this specification shall be in accordance with the surface

characterization requirements and the surface finish acceptance criteria defined herein.

6 Material Requirements

Materials used for components to be electropolished, so as to produce the surface characterization requirements contained herein, shall be in accordance with the metallurgical criteria defined in any of the following material specifications:

ASTM A 182, A 240, A 269, A 276, A 479, and A 632

SEMI F2 and SEMI F16

7 Surface Characterization Requirements

7.1 The internal (wetted) surface of all components shall be electropolished in accordance with a qualified process applicable to the material composition and type of component being processed.

7.2 Components used to qualify the electropolishing process shall be maintained by the component supplier.

7.3 Chemical analysis (ESCA) shall have been performed on the electropolished surface of the components used to qualify the process in accordance with a separate document currently under development, so as to certify surface elemental composition and process effectiveness. Elemental composition shall be expressed in atomic percent units, and the analysis shall have verified a minimum chromium-to-iron ratio of 1.5:1 and a chromium oxide enrichment of a minimum chromium oxide-to-iron oxide ratio of 2:1. Certified laboratory analysis reports shall be maintained by the component supplier.

7.4 The chrome oxide layer, as determined by Auger (AES) depth profiling, at 1/2 oxygen peak, shall also have been performed on the electropolished surface of the components used to qualify the process in accordance with SEMI Doc. 2336 so as to certify that the chrome oxide layer is equal to or greater than 2 nanometers (20 Angstroms). Certified laboratory analysis reports shall be maintained by the component supplier.

7.5 Scanning Electron Microscopy (SEM) photographs shall have been taken of the electropolished surface used in accordance with ASTM F 1372 to qualify the process of components made from materials defined in Section 6 above. These photographs shall be maintained by the component supplier.