SEMI F20-0706E (Reapproved 0611)
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

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1 Purpose

1.1 The purpose of this specification is to define the metallurgical cleanliness requirements and material composition of 316L stainless steel required for use in the manufacture of components for general purpose, high purity, and ultra-high purity chemical (gas or liquid) distribution systems.

2 Scope

2.1 This specification defines the requirements for 316L stainless steel bar, forgings, and extruded shapes as specified in ASTM A276, plate stock as specified in ASTM A240, and tubing as specified in ASTM A269 and ASTM A632, for use in the manufacture of components used in general purpose and high purity chemical (gas or liquid) distribution systems in semiconductor manufacturing facilities.

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 Referenced Standards and Documents

3.1 *ASTM Standards*[1]

ASTM A182/A182M — Specification for Forged or Rolled Alloy-Steel Pipe Flanges, Forged Fittings, and Valves and Parts for High Temperature Service

ASTM A240/A240M — Specification for Heat-Resisting Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels

ASTM A262 — Practices for Determining Susceptibility to Intergranular Attack in Austenitic Stainless Steels

ASTM A269 — Standard Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Service

ASTM A276 — Specification for Stainless and Heat-Resisting Steel Bars and Shapes

ASTM A479/A479M — Specification for Stainless and Heat Resisting Steel Bars and Shapes for Use in Boilers and Other Pressure Vessels

ASTM A480/A480M — Specification for General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet and Strip

ASTM A484/A484M — Specification for General Requirements for Stainless and Heat-Resisting Wrought Steel Products (Except Wire)

ASTM A632 — Standard Specification for Seamless and Welded Austenitic Stainless Steel Tubing (Small-Diameter) for General Service

ASTM A751 — Test Methods, Practices and Terminology for Chemical Analysis of Steel Products

[1] American Society for Testing and Materials, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959, USA; Telephone: 610.832.9585, Fax: 610.832.9555, http://www.astm.org

ASTM E45 — Recommended Practice for Determining the Inclusion Content of Steel

ASTM E112 — Test Methods for Determining Average Grain Size

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

4 Terminology

4.1 *Definitions*

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

4.1.2 *Grades*

4.1.2.1 *general purpose (GP) grade* — for components intended for use in chemical distribution systems of semiconductor manufacturing facilities that do not have stringent cleanliness requirements. Examples are clean dry air and vacuum lines.

4.1.2.2 *high purity (HP) grade* — for components intended for use in high performance capability chemical distribution systems of semiconductor manufacturing facilities.

4.1.2.3 *ultra high purity (UHP) grade* — for components intended for use in advanced chemical distribution systems of semiconductor manufacturing facilities in which optimum resistance to corrosion and contamination in critical process chemicals are required.

5 Ordering Information

5.1 Orders for bar, forgings, extruded shapes, plate, or tubular products under this specification shall include:

5.1.1 *Grade* — General purpose, high purity, or ultra-high purity,

5.1.2 Quantity (kilograms, pounds, meters, inches, or feet),

5.1.3 Cross section description (round, square, hex, etc. or detailed drawing),

5.1.4 Size (nominal diameter or shape dimensions for other than those identified with an extrusion drawing),

5.1.5 Wall thickness (for tubing),

5.1.6 Length (specific or random),

5.1.7 Reference to this specification number, and

5.1.8 Any special and/or supplementary requirements such as melting and refining processes.

6 Requirements

6.1 *General*

6.1.1 Bar stock, forgings, or extruded shapes furnished under this specification shall conform to the requirements of ASTM A182/A182M, ASTM A276, ASTM A479/A479M, or ASTM A484/A484M, and the additional requirements of this specification.

6.1.2 Plate stock furnished under this specification shall conform to the requirements of ASTM A240 or ASTM A480/A480M, and the additional requirements of this specification.

6.1.3 Tubing furnished under this specification shall conform to the requirements of ASTM A269 or ASTM A632, and the additional requirements of this specification.

6.1.4 Where the requirements of this specification conflict with referenced specifications, the requirements of this specification take precedence.

6.2 *Manufacture*

6.2.1 The stainless steel billet material used for processing shall be manufactured by such melting, casting and refining processes required to conform to the composition and metallurgical requirements of this specification.

6.2.2 The annealing temperature used to achieve the grain size requirements of ¶ 6.4.1 shall be 982°C (1800°F) minimum.

6.3 *Composition*

6.3.1 Material shall be type 316L stainless steel, as specified in Table 1 of ASTM A182/A182M, ASTM A240, ASTM A269, ASTM A276, ASTM A479/A479M, or ASTM A632, except where otherwise specified herein.

6.3.2 General purpose grade material shall have a composition per ASTM A269 and ASTM A632, with the exception of limited Sulfur 0.012% maximum.

6.3.3 Additional composition requirements for the high purity and ultra-high purity grades are shown in Table 1.

Table 1 Additional Composition Requirements

Element	*Range – Wt %*
Carbon	0.030 Max
Sulfur	0.010 Max
Manganese	1.5 Max
Copper	0.30 Max[#1]
Niobium	0.05 Max
Aluminum	0.01 Max
Calcium	0.02 Max
Titanium	0.02 Max
Selenium	0.02 Max

#1 Agreement may be reached between the supplier and the customer to accept a higher level of copper.

6.3.4 Effects of Sulfur content on welding are significant, as discussed in Appendix 1.

6.3.5 Effects of Copper content on welding are discussed in Appendix 2.

6.3.6 No deviations in material composition from the minimum or maximum values specified in the appropriate ASTM document or herein shall be allowed without approval by the purchaser.

6.4 *Metallurgy*

6.4.1 Grain size per ASTM E112 shall be 5 or finer for hot or cold finished product and tubing of nominal size 3 inches in diameter and smaller, and 3 or finer for material stock greater than 3 inches. These requirements may be modified as agreed upon between supplier and user. Grain size on flats and squares shall be as agreed upon by the supplier and the user.

6.4.2 The inclusion content of the material shall be determined from representative samples of the material heat in accordance with ASTM E45, Method A, but with ratings based on Plate III. Maximum allowable JK ratings at the billet stage are shown in Table 2.

Table 2 Maximum JK Inclusion Ratings

Type	*General Purpose Grade*		*High Purity Grade*		*Ultra-High Purity Grade*	
	Thin	*Heavy*	*Thin*	*Heavy*	*Thin*	*Heavy*
A	2.5	1.0	2.0	1.0	1.5	1.0
B	2.5	1.0	2.0	1.0	1.0	1.0
C	2.5	1.0	2.0	1.0	1.0	1.0
D	2.5	1.0	2.0	1.0	1.0	1.0