Photovoltaic Process Specification (SC-06)

Specification SCS-00006 Revision –

Scope

This document specifies guidelines used by Swagelok Company for producing stainless steel products intended for photovoltaic (PV) applications. This document must be used in conjunction with product catalogs, technical bulletins, and reports for complete product information. Application of this document is limited to wetted system components.

Design

Products are designed with specific functional industry standards in mind. Where specific test results exist in the literature, the following standards are applicable:

- Moisture analysis in accordance with ASTM F1397, "Standard Test Method for Determination of Moisture Contribution by Gas Distribution System Components"
- Hydrocarbon analysis in accordance with ASTM F1398, "Standard Test Method for Determination of Total Hydrocarbon Contribution by Gas Distribution System Components"
- Ionic cleanliness in accordance with ASTM F1374, "Standard Test Method for the Determination of Ionic/Organic Extractables of Internal Surfaces—IC/GC/FTIR for Gas Distribution Systems Components."

Materials Guidelines

Stainless steel is the industry-preferred material for UHP products used in gas systems due to the inherent properties of corrosion and oxidation resistance. AISI type 316L (UNS S31603) low-carbon stainless steel is most commonly used in industry due to the resistance to intergranular corrosion following welding or stress relieving. Valve seats, diaphragms, gaskets, and O-rings may be available in a variety of materials to meet end-customer requirements for chemical compatibility.

Stainless steel bar stock conforms to the following standards:

- ASTM A479, "Stainless and Heat-Resisting Bars and Shapes for Use in Boilers and Other Pressure Vessels"
- ASTM A484, "Specification for General Requirements for Stainless and Heat-Resisting Bars, Billets, and Forgings"
- ASTM A276, "Stainless and Heat-Resisting Bars and Shapes"
- SEMI F20-0305, "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."

Primary steel processing is either argon oxygen decarburization (AOD) or vacuum induction melting (VIM). A secondary remelt operation such as vacuum arc remelt (VAR) may be used for additional cleanliness of wetted components.

Key requirements of certain elements within the chemical make-up have been tightened by Swagelok for more consistency of chemical make-up; see Table 1.

Verifications of stainless steel products include but are not limited to the following:

- Material conformity is verified in accordance with Practice A of ASTM A262, "Standard Practices for Detecting Susceptibility to Intergranular Attack in Austenitic Stainless Steels."
- Chemical composition is verified in accordance with ASTM A751, "Test Methods, Practices, and Terminology for Chemical Analysis of Steel Products."
- Surface quality is verified through ultrasonic testing in accordance with ASTM E214, "Practice for Immersed Ultrasonic Testing by the Reflection Method Using Pulsed Longitudinal Waves" or through an eddy current test performed in accordance with Swagelok standards.
- Inclusions are detected by performing a JK test in accordance with ASTM E45, "Standard Practice for Determining the Inclusion Content of Steel, Method A," with ratings based on Plate I-r.

Table 1: Swagelok Specifications, wt %

Element	Swagelok 316 AOD	Swagelok 316L AOD	Swagelok 316L VAR	Swagelok 316L VIM-VAR
C (carbon)	0.035 to 0.050	0.015 to 0.030	0.015 to 0.030	0.015 to 0.030
S (sulfur)	0.020 to 0.030	0.005 to 0.030	0.005 to 0.012	0.005 to 0.010
Mn (manganese)	1.50 to 2.00	1.00 to 1.50	1.00 to 1.50	0.15 to 0.40

Manufacturing and Surface Finish

During manufacturing, dimensions and surface finishes are monitored closely. Each machined component has extremely fine surface finishes, smooth transitions, fully swept flow paths, and square weld ends to minimize the number of entrapped or generated particles.

- Surface roughness/finish criteria are based on SEMI F19, "Specification for the Surface Condition of the Wetted Surfaces of Stainless Steel Components" and the procedures of SEMI F37, "Method for Determination of Surface Roughness Parameters for Gas Distribution System Components."
- Swagelok roughness numbers published in product catalogs refer to the process mean, or the roughness value that represents the arithmetic average for a given production process in accordance with SEMI F37.
- Surface roughness/finish is verified by using a suitable profiling instrument in accordance with ASME B46.1. Measurements are taken over the maximum available length of the fitting or valve bore, excluding tapered surfaces, intersections, or welds.

IMPORTANT PROCESS NOTE:

Only *electropolished* ultrahigh-purity products are processed in accordance with the guidelines in the following two sections (*Electropolishing and Passivation* and *Electrochemical Critical Pitting Temperature)* of this document. Products with ordering numbers that contain a P6 designator are subject to these additional process requirements; products with ordering numbers that contain an SC06 designator are not affected.

Electropolishing and Passivation

This section refers to electropolished products *only.*

The wetted surfaces of fittings and valve bodies are electropolished to improve surface conditions and to form a corrosion resistant surface layer of chromium oxide. After electropolishing, all surfaces are passivated to remove free iron.

- Electropolishing processes are based on ASTM B912, "Standard Specification for Passivation of Stainless Steels Using Electropolishing" and are processed using custom fixturing.
- Passivation and pre-electropolishing cleaning processes are based on ASTM A380, "Cleaning, Descaling, and Passivation of Stainless Steel Parts, Equipment, and Systems."
- Verification of electropolishing and passivation is performed in accordance with test methods in section 6 of ASTM B912, "Standard Specification for Passivation of Stainless Steels Using Electropolishing."

Electrochemical Critical Pitting Temperature

This section refers to electropolished products *only.*

The electrochemical critical pitting temperature (CPT) test, based on ASTM G150, is used to determine resistance to localized pitting corrosion. The CPT test measures the temperature at which the current density increases rapidly beyond a set limit at a set electrical potential. Sodium chloride solution is used, and the electrical potential is held constant in the passivation region.

Table 2: Critical Pitting Temperature

Parameter	Specification	Test Method
Critical pitting temperature	>10°C (50°F)	ASTM G150

Cleaning and Drying

The DI water cleaning system is closed to the outside environment and thereby limits particle contamination. Products are cleaned in multistep processes through a series of heated ultrasonic washing, DI water rinsing, and a filtered drying chamber. Cleaning agents are selected in accordance with ASTM G127.

- The DI water characteristics are based on the guidelines of ASTM D5127 Type E-3, "Standard Guide for Ultra-Pure Water Used in the Electronics and Semiconductor Industries."

Table 3: DI Water Characteristics

Characteristic	Swagelok Capabilities
Resistivity	≥ 12 MΩ·cm at 25°C (77°F)
Total organic carbon (TOC)	< 300 ppb
Silica	< 50 ppb
Bacteria	< 50 colonies per 100 milliliters

Assembly and Testing

To protect parts from airborne contamination, parts are covered and transported directly from the established cleaning system to a clean work cell for assembly and testing. Specific product performance test requirements and results may be obtained from the product catalog.

Packaging and Identification

Swagelok® products are packaged to keep products free from outside contaminants during shipping. Identification and traceability information is visible without opening the product package to reduce the chances for contamination of the product and the system to which it is being assembled.

- Packaging and identification procedures meet the requirements of SEMI E49.6, "Guide for Subsystem Assembly and Testing Procedures—Stainless Steel Systems" for stainless products.

Referenced Documents

ASME

ASME B46.1, “Surface Texture (Surface Roughness, Waviness and Lay)”

ASTM

ASTM A262, “Standard Practices for Detecting Susceptibility to Intergranular Attack in Austenitic Stainless Steels”

ASTM A276, “Stainless and Heat-Resisting Bars and Shapes”

ASTM A380, “Cleaning, Descaling, and Passivation of Stainless Steel Parts, Equipment, and Systems”

ASTM A479, “Stainless and Heat-Resisting Bars and Shapes for Use in Boilers and Other Pressure Vessels”

ASTM A484, “Specification for General Requirements for Stainless and Heat-Resisting Bars, Billets and Forgings”

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

ASTM B912, “Standard Specification for Passivation of Stainless Steels Using Electropolishing”

ASTM E45, “Standard Practice for Determining the Inclusion Content of Steel, Method A”

ASTM D5127 Type E-3, “Standard Guide for Ultra-Pure Water Used in the Electronics and Semiconductor Industries”

ASTM E214, “Practice for Immersed Ultrasonic Testing by the Reflection Method Using Pulsed Longitudinal Waves”

ASTM F1374 “Standard Test Method for the Determination of Ionic/Organic Extractables of Internal Surfaces—IC/GC/FTIR for Gas Distribution Systems Components”

ASTM F1397 “Standard Test Method for Determination of Moisture Contribution by Gas Distribution System Components”

ASTM F1398 “Standard Test Method for Determination of Total Hydrocarbon Contribution by Gas Distribution System Components”

ASTM G127 “Guide for the Selection of Cleaning Agents for Oxygen Systems”

ASTM G150, “Standard Test Method for Electrochemical Critical Pitting Temperature Testing of Stainless Steels”

SEMI

SEMI E49.6, “Guide for Subsystem Assembly and Testing Procedures—Stainless Steel Systems”

SEMI F19, “Specification for the Surface Condition of the Wetted Surfaces of Stainless Steel Components”

SEMI F20-0305, “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”

About this document

Thank you for downloading this electronic catalog, which is part of General Product catalog Swagelok published in print. This type of electronic catalog is updated as new information arises or revisions, which may be more current than the printed version.

Swagelok Company is a major developer and provider of fluid system solutions, including products, integration solutions and services for industry research, instrumentation, pharmaceutical, oil and gas, power, petrochemical, alternative fuels, and semiconductor. Our manufacturing facilities, research, service and distribution facilities support a global network of more than 200 authorized sales and service centers in 57 countries.

Visit www.swagelok.com to locate your Swagelok representative and obtain any information on features, technical information and product references, or to learn about the variety of services available only through authorized sales centers and service Swagelok.

Safe Product Selection

When selecting a product, the total system design must be considered to ensure safe, trouble-free performance. Function, material compatibility, adequate ratings, proper installation, operation, and maintenance are the responsibilities of the system designer and user.

Warranty Information

Swagelok products are backed by The Swagelok Limited Lifetime Warranty. For a copy, visit your Swagelok Web site or contact your authorized Swagelok representative.

Swagelok, Ferrule-Pak, Goop, Hinging-Colleting, IGC, Kenmac, Micro-Fit, Nupro, Snoop, Sno-Trik, SWAK, VCO, VCR, Ultra-Torr, Whitey—TM Swagelok Company
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