

# Ultra-High Purity Process Specification (FC-03)

This Specification is enacted for FITOK Ultra-High Purity Products.

This Specification stipulates the requirements for raw material, machining, electro-polishing, cleaning, welding, assembly, testing and packaging.

## Process Requirements

- ⦿ This Specification applies only to Stainless Steel products.
- ⦿ Only High Purity Stainless Steel materials could be utilized. The wetted interior surface contacted with media should be electro-polished.
- ⦿ Ultra-High Purity cleaning, welding, assembly, testing and packaging should be performed in clean environment to prevent products from contamination.
- ⦿ Products are double packaged with polyethylene bags, with the outer packing bags labeled with process identification.

## Raw Materials

- ⦿ AISI 316L (UNS S31603) Stainless Steel is commonly used for High Purity (HP) and Ultra-High Purity (UHP) Products, which have excellent corrosion resistance and oxidation resistance.
- ⦿ By Argon Oxygen Decarburization (AOD) or Vacuum Oxygen Decarburization (VOD), Stainless Steel material could be refined. The detrimental chemicals including C, Mn, Si, P, S and etc. could be controlled at low level. Subsequently, Vacuum Arc Remelting (VAR) would be able to further purify the material and to give full play to its excellent characteristics. The Stainless Steel material that has been through VOD, VIM and VAR processes to minimize its content of C, Mn, Si, P, S, is named 316L VIM-VAR.
- ⦿ Please refer to Table 1 below for the key compositions of the Stainless Steel material FITOK utilized for our products for Ultra-High Purity applications.

Table 1

Material	Composition, %		
	C	S	Mn
316L	≤ 0.03	≤ 0.01	≤ 1.5
316L VAR	≤ 0.03	≤ 0.005	≤ 1.5
316L VIM-VAR	≤ 0.03	≤ 0.005	≤ 0.4

- ⦿ Stainless Steel Material Standards:
  - ASTM A479, Standard Specification for Stainless Steel Bars and Shapes for Use in Boilers and Other Pressure Vessels;
  - ASTM A484, Standard Specification for General Requirements for Stainless Steel Bars, Billets, and Forgings;
  - ASTM A276, Standard Specification for Stainless Steel Bars and Shapes;
  - 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.
- ⦿ Material Inspection Standards:
  - Intergranular Corrosion Test: ASTM A262, Standard Practices for Detecting Susceptibility to Intergranular Attack in Austenitic Stainless Steels;
  - Chemical Composition Analysis: ASTM A751, Standard Test Methods, Practices, and Terminology for Chemical Analysis of Steel Products;
  - Ultrasonic Test of Material Interior Defects: ASTM E214, Standard Practice for Immersed Ultrasonic Examination by the Reflection Method Using Pulsed Longitudinal Waves;
  - Materials Inclusion Content Analysis: ASTM E45, Standard Test Methods for Determining the Inclusion Content of Steel, with rating according to Plate III.

## Machining

- ⦿ During the machining process, dimensions and surface finish of the products should be strictly controlled to ensure fine finish of each machined surface, smooth chamfer, flow pass and weld to eliminate any risk of defect and particles.
- ⦿ Surface Roughness:  
SEMI F19, Specification for the Surface Condition of the Wetted Surfaces of Stainless Steel Components;  
SEMI F37, Method for Determination of Surface Roughness Parameters for Gas Distribution System Components.
- ⦿ Flow Pass Surface Roughness of the FITOK Ultra-High Purity Products could be controlled less than Ra 5  $\mu\text{in}$ . (0.13  $\mu\text{m}$ ).

## Electro-polishing

- ⦿ Interior surface of FITOK Ultra-High Purity Products should be electro-polished to improve the smoothness of flow pass and corrosion resistance by forming chromium-rich layer on the metal surface. The electro-polished products should be passivated to remove free iron ions.
- ⦿ Electro-polishing and Passivation Standards:  
ASTM E1558, Standard Guide for Electrolytic Polishing of Metallographic Specimens;  
ASTM A380, Standard Practice for Cleaning, Descaling, and Passivation of Stainless Steel Parts, Equipment, and Systems.
- ⦿ Please refer to Table 2 below for the specification of the electro-polished FITOK products for Ultra-High Purity applications.

Table 2

Parameter		Specification	Test Method
Oxide thickness		$\geq 15\text{A}$	SEMI F72
Surface defect analysis	Over 5 sample areas, maximum of each area	$\leq 40$ pcs	SEMI F73
Chromium-to-Iron (Cr/Fe)		$\geq 1.5:1$	SEMI F60
Chromium oxide-to-Iron oxide (CrO/FeO)		$\geq 2:1$	
Surface roughness (Ra)		$\leq 5 \mu\text{in}$ .	SEMI F37

## Cleaning and Drying

- ⦿ Products should have fulfilled the requirements of the *FITOK Special Cleaning and Packaging Process (FC-02)* before cleaning according to this Specification.
- ⦿ Carry out ultrasonic washing with DI water in the clean room.
- ⦿ After cleaning, dry the products by the closed oven in the clean room.
- ⦿ DI Water Standards:  
SEMI E49.6, Guide for Subsystem Assembly and Testing Procedures - Stainless Steel Systems.

Table 3 Parameters of DI Water

Characteristic	Capabilities
Resistivity	$\geq 17.5 \text{ M}\Omega\cdot\text{cm}$ at 25°C (77°F)
Total organic carbon (TOC)	< 20 ppb
Silica	< 5 ppb
Bacteria	< 10 colonies per 100 milliliters
Hot DI water temperature	176°F (80°C) minimum

## Welding, Assembly and Testing

- ⦿ To prevent the cleaned products polluting by the particles and dusts in the air, the cleaned products shall be sent in the clean room directly to finish welding, assembly and testing.
- ⦿ The clean room is up to the requirement of ISO 14644-1 Class 5, which are equivalent to Federal Standard 209E Class 100.

## Packaging and Labeling

- © During storage and transportation, the products should be protected from damage and contamination as below:
  - The functional ports of the product, such as: male threads, sealing surfaces, which should be protected with clean protective films and proper caps.
  - Finished products should be double packaged, the inner layer uses the plastic bag in polyethylene and free-dust for vacuum sealing, and the outer layer is sealed by polyethylene plastic bag with clean and dry nitrogen.
  - Finished products in the bags should be packed in the boxes for protection.
  - Finished products' packaging markings and traceable information should be clear and visible before removing the packing.
- © Product Packaging Standard:
  - SEMI E49.6, Guide for Subsystem Assembly and Testing Procedures - Stainless Steel Systems.

## References

### **ASTM**

- ASTM A262, Standard Practices for Detecting Susceptibility to Intergranular Attack in Austenitic Stainless Steels
- ASTM A276, Standard Specification for Stainless Steel Bars and Shapes
- ASTM A380, Standard Practice for Cleaning, Descaling, and Passivation of Stainless Steel Parts, Equipment, and Systems
- ASTM A479, Standard Specification for Stainless Steel Bars and Shapes for Use in Boilers and Other Pressure Vessels
- ASTM A484, Standard Specification for General Requirements for Stainless Steel Bars, Billets, and Forgings
- ASTM A751, Standard Test Methods, Practices, and Terminology for Chemical Analysis of Steel Products
- ASTM E45, Standard Test Methods for Determining the Inclusion Content of Steel
- ASTM E214, Standard Practice for Immersed Ultrasonic Examination by the Reflection Method Using Pulsed Longitudinal Waves
- ASTM E1558, Standard Guide for Electrolytic Polishing of Metallographic Specimens
- ASTM F1397, Standard Test Method for Determination of Moisture Contribution by Gas Distribution System Components

### **SEMI**

- SEMI F19, Specification for the Surface Condition of the Wetted Surfaces of Stainless Steel Components
- 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 E49.6, Guide for Subsystem Assembly and Testing Procedures-Stainless Steel Systems
- SEMI F60, Test Method for ESCA Evaluation of Surface Composition of Wetted Surfaces of Passivated 316L Stainless Steel Components
- 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

### **ISO**

- ISO 14644-1, Cleanrooms and Associated Controlled Environments