

Process Specification

Fittings

- Ⓒ Standard Cleaning and Packaging (FC-01)
- Ⓒ Special Cleaning and Packaging (FC-02)
- Ⓒ Ultra High Purity (FC-03)

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Process Comparison

Process Specification Item	Standard Cleaning and Packaging (FC-01)	Special Cleaning and Packaging (FC-02)	Ultra High Purity (FC-03)
Application	This specification specifies the standard cleaning, lubrication, assembly and packaging methods to meet the requirements of the general industry for cleanliness.	This specification is designed to adapt to the application of rich oxidation environment, and has been developed to meet the cleaning process of ASTM G93 Class C standard.	This specification is a process designed to meet the ultra high cleanliness requirements of the semiconductor industry. Suitable for 316L stainless steel and nickel alloy.
Cleaning	Three times degreasing ultrasonic cleaning	Seven times degreasing ultrasonic cleaning, deionized water.	Nine times degreasing ultrasonic cleaning, deionized water, and finally cleaning in the cleanroom.
Assembly Environment	At atmosphere	In specially cleaned areas	Federal 10 cleanroom
Lubrication	No restrictions on the use of lubricants for components in contact with the medium.	Components in contact with the medium shall be applied with special lubricants compatible with oxygen, such as DuPont GPL 227 (standard) DuPont 240 AC (optional)	No lubricants for the components in contact with the medium
Testing	Air, nitrogen or helium, bubble method, or helium leak detection.	Nitrogen or helium, bubble method, or helium leak detection.	Nitrogen or helium. Helium leak detection
Packaging	Individually bagged	Double bagged	Double bagged in cleanroom

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Standard Cleaning and Packaging Process (FC-01)

- ⦿ This Specification applies to the standard cleaning, lubrication, assembly and packaging of FITOK products.
- ⦿ Please read this Specification carefully before using the product to make sure it is up to the cleanliness requirements of your system.

Process Requirements

- ⦿ Particles and oil contamination on products from the manufacturing process should be eliminated according to the process requirements.
- ⦿ Components to be assembled should be lubricated according to the requirements of the products.
- ⦿ Finished products should be properly packaged to avoid damages during storage and shipment.
- ⦿ Each product should be marked for easy identification.

Cleaning and Inspection

- ⦿ Carry out continuous ultrasonic cleaning to eliminate the smudges on the products from the manufacturing process, such as: cutting oils, polishing waxes and other dust particles.
- ⦿ Carbon steel products are protected from atmospheric corrosion by plating, conversion coating or with a light oil film.
- ⦿ Carry out visual inspection under bright lighting or violet lighting conditions, or use clean cloth to wipe for inspection.

Lubrication, Assembly and Testing

- ⦿ Greases should be applied to threads, mating surfaces, O-rings, and seals to form a lubricating film to prevent galling, to reduce friction and to enhance sealing effect. These greases are generally hydrocarbons, halogen contained hydrocarbon or silicon oil containing inorganic additives.
- ⦿ Cleaned products should be assembled in clean and well-lighted environment.
- ⦿ Use clean and dry air, nitrogen or helium to test according to the requirements of the products. Use clean tap water for hydrostatic pressure test. Dry the internal and external surfaces after passing the test.

Packaging and Labeling

- ⦿ Finished products should be packaged well to prevent them from damage or contamination during shipment and storage.
- ⦿ The functional ports of the product, such as: male thread, sealing surface should be protected with cap and proper plug.
- ⦿ Protected products should be packaged in the boxes with standard quantity according to the requirements.
- ⦿ Boxes should be labeled with part number, quantity and packaging date.
- ⦿ Nuclear grade products should be packaged in accordance with the requirements of ASME NQA-1.

Reference

*ASME Standard
NQA-1 Quality Assurance Requirements for Nuclear Facility Applications*

Special Cleaning and Packaging Process (FC-02)

- ⦿ This Specification applies to the cleaning, lubrication, assembly and packaging in oxygen-enriched environments of FITOK products.
- ⦿ The cleanliness of the product wetted parts is in accordance with ASTM G93, Level C.
- ⦿ Please read this Specification carefully before using the product to make sure it is up to the cleanliness requirements of your system.

Process Requirements

- ⦿ Products should have fulfilled the requirements of FITOK Standard Cleaning and Packaging Process (FC-01) before proceeding according to this Specification.
- ⦿ According to the requirements of ASTM G93, Level C, non-volatile residues should not exceed 6 milligrams per square foot (66 mg/m²).
- ⦿ All lubricants applied for assembly of the products should be non-hydrocarbon lubricants which are in harmony with oxygen environments, such as KrytoxGPL227 (standard), Krytox240AC (optional).
- ⦿ Products are double packaged with polyethylene bags, with the outer packing bags labeled with process identification.

Cleaning and Inspection

- ⦿ The product should go through continuous ultrasonic cleaning, the procedures of which should be monitored in accordance with the requirements of ASTM G144. The inspection methods shall conform to the requirements of ASTM G121 and G122.
- ⦿ Carry out ultrasonic cleaning in accordance with the requirements of ASTM G131 with the cleaning agent complying with ASTM G127.
- ⦿ Use DI Water to proceed ultrasonic rinsing and spray washing according to the requirement of ASTM G313.
- ⦿ Eliminate cleaning fluid through non-combustive drying to ensure there is no residue deposit.
- ⦿ Carry out visual inspection under bright lighting or ultraviolet lighting conditions. Inspect the surface cleanliness of products with a dyne pen.

Lubrication, Assembly and Testing

- ⦿ Cleaned parts should be protected to avoid damage or contamination.
- ⦿ All proceedings of the cleaned parts shall be carried out in the clean room in accordance with a rational workflow to keep the parts away from contamination.
- ⦿ During assembly, lubricate the parts where needed with non-hydrocarbon grease to reduce friction, improve sealing and to ensure product cleanliness.
- ⦿ Factory testing of products is carried out with clean, dry nitrogen or helium.

Packaging and Labeling

- ⦿ Finished products are packaged in clean environment to protect them from contamination.
- ⦿ The ports of products are sealed with caps, plugs or other means to protect the important positions and at the same time to prevent the contamination getting inside the products.
- ⦿ Each product is packaged individually with a sealed clean plastic bag.
- ⦿ Bagged products are packed in boxes for protection.
- ⦿ Part number, quantity, and packing date are labeled on the boxes.

References

Standard Cleaning and Packaging Process (FC-01)

ASTM standards

ASTM G93 Standard Practice for Cleaning Methods and Cleanliness Levels for Material and Equipment Used in Oxygen-Enriched Environments

ASTM G121 Standard Practice for Preparation of Contaminated Test Coupons for the Evaluation of Cleaning Agents

ASTM G122 Standard Test Method for Evaluating the Effectiveness of Cleaning Agents

ASTM G127 Standard Guide for the Selection of Cleaning Agents for Oxygen Systems

ASTM G131 Standard Practice for Cleaning of Materials and Components by Ultrasonic Techniques

ASTM G144 Standard Test Method for Determination of Residual Contamination of Materials and Components by Total Carbon Analysis Using a High Temperature Combustion Analyzer

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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, electropolishing, cleaning, welding, assembly, testing and packaging.

Process Requirements

- ⦿ Only high purity stainless steel materials could be utilized. The wetted internal surface contacted with media should be electro-polished.
- ⦿ Ultra High Purity cleaning in Federal Class 100 cleanroom, and welding, assembly, testing and packaging should be performed in Federal 10 cleanroom 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 has 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 utilizes for our products for Ultra High Purity applications.

Table 1

Material	Composition, %		
	C	S	Mn
316L	≤0.03	≤0.012	≤2.0
316L VAR	≤0.03	≤0.010	≤1.5
316L VIM-VAR	≤0.03	≤0.010	≤1.5

- ⦿ 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 path surface roughness of FITOK Ultra High Purity Products could be controlled to less than Ra 5 μin. (0.13 μm).

Electropolishing

- ⦿ Internal surface of FITOK Ultra High Purity Products should be electropolished to improve the smoothness of flow path and corrosion resistance by forming chromium-rich layer on the metal surface. The electropolished products should be passivated to remove free iron ions.
- ⦿ Electropolishing 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 electropolished FITOK products for Ultra High Purity applications.

Table 2

Parameter		Specification	Test Method
Oxide Thickness		≥15Å	SEMI F72
Surface Defect Analysis	Over 5 Sample Areas, Maximum of Each Area	≤40pcs	SEMI F73
Chromium-to-Iron (Cr/Fe)		≥1.5:1	SEMI F60
Chromium Oxide-to-Iron Oxide (CrO/FeO)		≥2:1	
Surface Roughness (Ra)		≤Ra 0.13 μm (5 μin.)	SEMI F37

Cleaning and Inspection

- ⦿ Products should have fulfilled the requirements of 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	≥17.5 MΩ·cm (25°C/77°F)
Total Organic Carbon (TOC)	20ppb
Silica	5ppb
Bacteria	10 colonies per 100 milliliters
Hot DI Water Temperature	176°F (80°C) minimum

Welding, Assembly and Testing

- ⦿ To prevent the cleaned products polluted 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 is equivalent to Federal Standard 209E Class 100.
- ⦿ High purity nitrogen or helium is used for the factory test of the products.

Packaging and Labeling

- ⦿ During storage and transportation, the products should be protected from damage and contamination as below:
 - ⦿ The functional parts of the product, such as: male threads, sealing surfaces, 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.
 - ⦿ 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

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ASTM

- STM 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*

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