JAPAN MACHINERY COMPANY
Overseas Operations Division

DATA SHEET

Vacuum Sintering Furnace

For

Tantalum/Niobium Capacitor Chip

VESTA II (VSFC 3 / 20)

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1. GENERAL DESCRIPTION

1.1 Introduction

This book is prepared to offer to customers a primary Technical Information about the Vacuum Sintering Furnace for Tantalum or Niobium Capacitor Chips developed by OPPC Co., Ltd., Japan.

1.2 Designation

VESTA II (VSFC 3 / 20)

VSFC = Vertical Vacuum sintering Furnace for Tantalum/Niobium Capacitor

3 = Pumping Capacity of High Vacuum is 3,000 l/sec

20 = Maximum power of the sintering heater is 20 kW

1.3 Basic Design

This vertically Installed Vacuum Sintering Furnace for Capacitor has two (2) loading/unloading and cooling chambers and one (1) de-waxing and sintering chamber, High temperature and high vacuum heating device for sintering has an ability of maximum sintering temperature of 1700 °C with internally installed one (1) resistant heated graphite heater elements, also a soaking tube made of Molybdenum alloy and the radiation shield assembly made of graphite wool

It is preferably designed for sintering Tantalum/Niobium capacitor elements, especially the pellet of small size of high CV capacitance, in a small quantity and wide variety of the industrial scale.

1.4 Principles of the Process

At the Loading Station, air-activated manipulator loads one (1) unit of three (3) round ceramic pellet trays is installed automatically to the loading/unloading and cooling chamber from the storing station, and swing to the proper position. Then the loading/unloading and cooling chamber is pushed by air-activated manipulator to keep tight for vacuum. The loading/unloading and cooling chamber is evacuated until the pressure is ready to open the gate valve which is installed between sintering chamber. The ceramic tray unit is installed by the air-activated manipulator to set in the heating unit in the sintering chamber. At first, the de-waxing process is started and the temperature is raised up to approx. 200 °C ~ 500 °C. Processing temperature is raised up toward approx. 1250°C ~ 1550°C which is suitable for sintering. The pressure in the sintering chamber evacuated by diffusion pump is in the range of 10^{-4} ~ 10^{-5} mbar range.

After finishing the sintering process, a unit is transferred again to the loading/unloading and cooling chamber keeping in high vacuum, and is cooled down until less than approx.70°C. Then the unit is transferred to the loading/unloading and cooling chamber and the valve which attached to the loading/unloading and cooling chamber is closed. Argon gas is introduced and cooled down in a short time. During the cooling stage, the loading/unloading and cooling chamber is rotated to the loading/unloading position. Then, the ceramic tray unit is taken out after the temperature is less than approx.70°C and transferred to the storing station

The ceramic tray unit is always rotated even in the sintering process to secure the good temperature uniformity. Three thermo couples are installed in the center axis of the tray unit to observe the each ceramic tray and one of this thermo couples is controlling the heater power. With these methods, the temperature distribution in the ceramic tray has a very good uniformity.

The storing station can holds maximum five (5) tray units and it is possible to install each programmed recipe for the processing operation. All operation can be controlled in an automatic mode including process data acquisition.

1.5 Special features of the VESTA II (VSFC 3 / 20)

The important parts like heater elements and reflector in the furnace are designed and manufactured by ourselves. And highest reliability of entire furnace heater has been incorporated in the design of this versatile production furnace.

Vacuum pumps and control system come from Leybold AG; Germany and VAT AG; Switzerland, which are the world's best reliability and easily available in United States and EU.

The whole system including heating system is controlled by industrial controlling system supplied by OMRON Co. Japan.

2. TECHNICAL DATA OF THE VESTA II (VSFC 3 / 20)

2.1 Processing Material

Sintering unit made of ceramic tray with green capacitor pellets

Dimension of the unit	200mm Dia. x 130mmL
Number of the ceramic trays	3 per Unit
Dimension of the tray	200mm Dia. x 40mmL
Inner volume of each tray	700 cc

(Reference) Processing pieces of 0.5x0.6x0.5 size pellet: 13,000 pieces/tray

2.2 High Temperature (Sintering) Heating System

Graphite heater size	320 mm I.D. X 300mmL
Soaking tube made of Mo alloy size	300 mm I.D. X 300mmL
Heater power	20 kW
Max. Temperature	1700 °C (*)
Normal Operational Temperature	1250 ~ 1550 °C

* Details to be discussed separately.

2.3 Vacuum Pumping System

One (1) Main diffusion pump	DIP 3000	3,000 l/sec
One (1) Roots pump	WAU 251	250 m3/hr
One (1) Rotary pump	D65B	65 m3/hr
Two (2) Rotary pumps	D16B	16 m3/hr

2.4 Vacuum Spec. of High vacuum Furnace

Operational Pressure	< 1 X 10 -5 mbar
Leak rate	< 5 X 10 -5 mbar*l / sec

Evacuation .time down to 5 X 10-4 mbar is less than 10 min

2.5 Electrical Requirements

Max. Graphite heater power	20 kW
Power requirement of supply unit	25 KVA
Power requirement for the Utility	15 KVA
Total power requirement	40 KVA
Supply voltage	200 V 3 phase

(Other voltage is optional)

2.6 Water Requirement

Cold water

Through put	approx. 20 l/min
Pressure	2.5 - 3.5 bars
Max. Inlet temperature	25 °C

Requirement for water quality

Hydrogen Ion Concentration: PH6.5-8.0
Water Electrical Resistivity: 5kOhm·cm or more
Total Hardness: 100mg$CaCO_3$/L or less
Total Solids: 250mg/L or less
Chloride Ion: 50mg/L or less
Iron Ion: 1mg/L or less
Sulphate Ion: 50mgSO_4^{2-}/L or less
Ionic State Silica: 30mgSiO_2/L or less

2.7 Compressed Air

Quantity	approx. 10 l/min
Pressure	6 - 7 bars

2.8 Dimension and Weight

To be presented separately

3. SCOPE OF SUPPLY

3.1 Basic Furnace Unit

3.1.1 Loading/Unloading and cooling Chamber (two (2) sets)

The Loading/Unloading chamber consists of a cylindrical part of approx. ID 300-mm diameter and approx. 400-mm long made of stainless steel. This chamber is made as double walled and water cooled. The chamber is equipped with pendant drum gate valve which can evacuate or filled with gas independently from the main sintering chamber. The chamber is also equipped with the required opening for the installation of recirculation fan, water cooling plate and gauges. The cooling plate is effective for the rapid cooling of the tray unit. The pumping equipment is working not only for the evacuation of the chamber but also for the passivation process.

The movable heat shield plate is installed for the protection of the gate valve from the radiation of the hot tray unit.

3.1.2 Sintering Chamber and heater unit

(For details, see Fig. 3: Heater assembly)

The sintering chamber consists of a elliptical vessel of approx. 900-mm long X 300 mm width X 400 mm height.

The sintering chamber is equipped with the required opening for the installation of water-cooled power feed through for heater, opening for diffusion pump, right angle valve for diffusion pump, observation windows and vacuum gauges.

The sintering chamber is made as double walled and water cooled. Inside of the sintering chamber, which is exposed to the metal vapor, is made of stainless steel.

The heater element is made of graphite for 3-phase power supply and fixed through water-cooled feed through which are installed on the side of the sintering chamber. The reflector is also made of graphite, carbon fiber and heat resistant alloy sheet. Inside of the graphite heater, the Molybdenum alloy soaking tube is set for the uniform heat distribution and protect from the graphite fume from the heater unit.

One (1) thermo couple is installed for the temperature observation of the heater. The observation windows for heater buss bar and for the pyrometer with movable heat shield.(two color eye pyrometer is optional)

Heater unit is easily installed and removed for the cleaning of the vapor inside of the chamber, because the heater unit is very stable and rigid compared with the recrystallized refractory metal heater and reflector unit. The trapping shield is also installed inside of the chamber.

The movable heat shield plate is installed for the protection of the gate valve from the radiation from the heater unit

3.1.3 Tray unit retracting and rotating module (two (2) sets)

(For details, see Fig. 3: Heater assembly)

The ceramic made tray unit is installed on the ceramic heat shield and water cooled plate of the retracting and rotating unit. This unit can supply cooling water and take out of the signals from the thermo couples inside of the ceramic tube on which the tray unit is attached; even the module is rotating and retracting, with the universal valve and the slip ring.Three (3) thermo couples of W-Re is equipped in the center of each ceramic tray for the temperature observation. One of the proper thermo couple will apply for the heater controller unit.

The ceramic tray has an advantage of the uniform heat distribution compare with the tantalum tray, because the heat capacity is 10 times bigger. The ceramic tray is also very tough after the repeat heat and cool.

3.2 Vacuum System

(For details, see Fig. 2 Vacuum Diagram)

3.2.1 Vacuum Pumps and Valves

For sintering chamber, one (1) diffusion pump DIP 3,000 with the pumping speed of 3,000 l/sec is provided. Operating vacuum is the range of 10^{-5} mbar.

For the high vacuum pump, one (1) rotary vane pump D65B, a pumping speed of 65 m^{-3}/hr and roots pump WAU 251 a pumping speed of 250 m^{-3}/hr is provided.

Other pumps are also served for pre-evacuation and back-up for diffusion pump and the evacuation of the Loading/Unloading chamber.

Necessary automatic valves and measuring gauges are attached in order to secure proper operation of the total vacuum system.

3.3 Power Supply and Control system

3.3.1 Power Supply

The power supply unit for Graphite heater in the sintering furnace is in a maximum power of 20 kW at a lowest AC voltage of 30 V. This unit is high-voltage-proof for primary connection and is equipped with a current limit device.

The unit consists of One (1) main transformer with the power of 25 KVA and the primary voltage of 200 V, which is air cooled, one (1) set of thyristor control elements and one (1) set of programmable temperature control elements.

3.3.3 Control Unit

All control unit listed below, are installed inside of the common structure.

One (1) control elements for vacuum systems

One (1) control elements for heater control of sintering furnace

One (1) industrial controller system

3.4 Main Water Distribution Battery

The water supply is divided into the following cooling circuits:

Vacuum pumps (cold water)

All Chamber flanges (cold water)

All cooling circuits can be controlled at one (1) common water battery, which is located inside of the common base structures.

The water circuits for diffusion pumps, heater feed through and chamber walls are equipped with water flow switches for the interlocking of heater and power supply, respectively

3.5 Supervision and Commissioning

Supervision services the installation; test–run, commissioning and final acceptance testing at buyer's site is a part of the scope of supply.

3.6 Technical documentation

Three (3) sets of the following documentation will be provided:

General layout Drawing

Schematic Diagrams for

Vacuum system,

Cooling water and

Compressed air

Electrical schematics and Terminal Diagrams

Operating and Maintenance Instructions

Spare Parts Lists

4. WARRANTY

Seller will undertake to repair or replace equipment or a part thereof supplied by seller, which, within twelve (12) months or two thousand (2,000) operating hours after the date of shipment of equipment, proves to be, under normal operating conditions, of defective material or poor workmanship, and require repair or replacement.

5. APPENDIX

Fig. 1: Furnace Layout

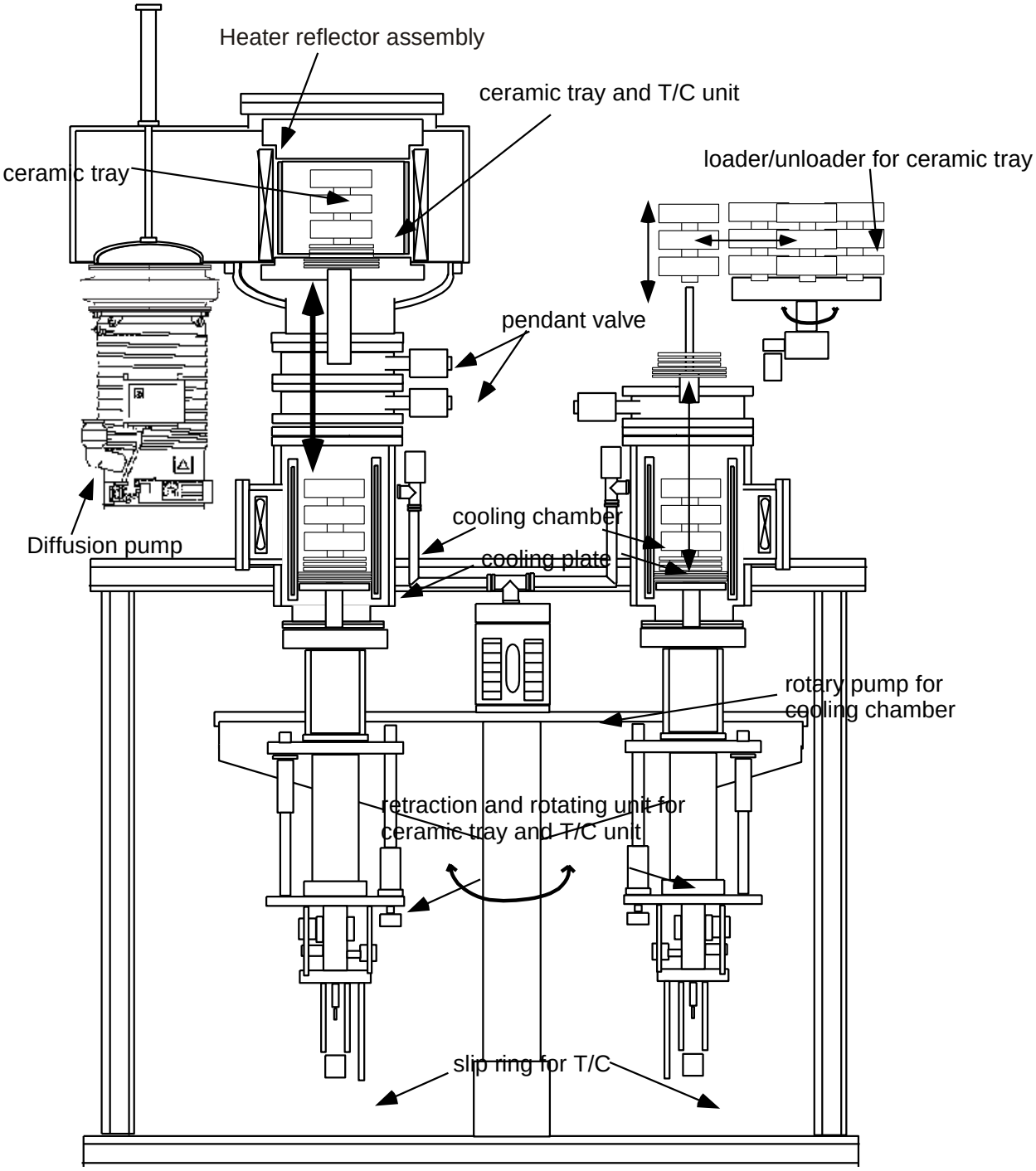

Fig. 2: Vacuum Diagram

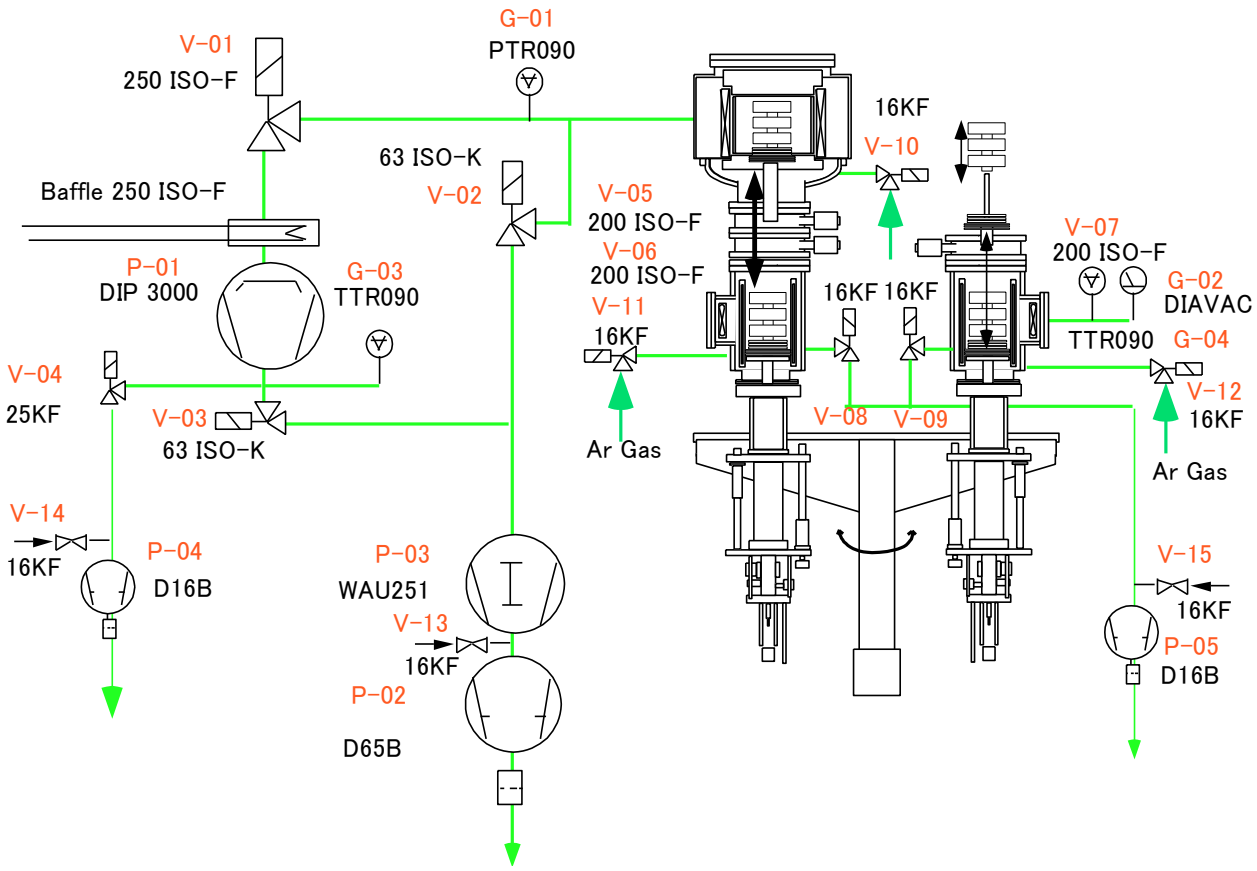

Fig. 3: Heater assembly