

ExTeM-CAPEX-003

Technical specifications for Microwave custom unit with loading capability

(all the conditions should be met)

Mandatory Technology requirement

- A. The proposed system should be capable of sintering any powder by heating through:
 - a. Conventional heating preferably resistance heating
 - b. Microwave heating by use of magnetrons
 - c. Hybrid heating (use of both microwave and direct heating) with the provision of furnace cum pressing chamber.
- B. The proposed system should have a provision to utilize the conventional as well as microwave heating mode separately and as well as in combined mode i.e., hybrid heating. Special switches/knobs should be provided for independent operation of Conventional heating, Microwave heating and Hybrid Heating. Detailed hybrid heating (% of manual heating + % of Microwave heating) capability should be clearly explained in the operational manual. Special swiches/knobs/Provisions should be provided for different level of hybrid heating (% of manual heating + % of Microwave heating).
- C. The whole process should have capability to function under ambience air, vacuum as well as under inert atmosphere (N₂, Ar) for the sintering of metals and alloys.
- D. Proper safety system to be provided for smooth functioning of the machine and safety of the operator.

1. FURNACE STRUCTURE

- 1.1. Furnace should be made with Stainless steel (SS) with double walled structure and with a provision of water-cooling system in order to maintain skin temperatures just above ambient.
- 1.2. Furnace shell should be constructed of SS Body and SS Angle's structure with proper stiffeners and neat powder coat painting.
- 1.3. Furnace should have a front-loading provision with user-friendly operation of loading and unloading of sample.

- 1.4. Safe view ports with quartz glass should be provided for sample viewing and placing temperature probes.
- 1.5. The chamber should be leak tight. The furnace should be comprised of reliable closed water-cooling system with efficient pressure and flow for continuous operation.
- 1.6. The Furnace should be comprised of pressure and flow switch for continuous monitoring and safe operation. It should have safety interlock and alarm indication, if the cooling water temperature increases to desired set temperature, decrease flow and pressure.
- 1.7. Furnace should have the multiple ports in the both the end such as connection for evacuation, gas inlet, gas out let and pressure gauge, all are having necessary valves and control for various environment (vacuum and inert gas).
- 1.8. It should be able to withstand a vacuum of minimum 1×10^{-5} torr.
- 1.9. The furnace SS shell should be of 500mm (or more) X 500 mm long (or more) X 500 mm (or more).
- 1.10. The minimum heating zone for the furnace should be 150mm x 150mm x 150mm.

2. CONVENTIONAL HEATING SYSTEM

- 2.1. Heating elements to be utilized for the conventional heating purpose should made up of high temperature material (preferably Molybdenum di silicide rods) so as to sustain a temperature of 1700 deg C.
- 2.2. Heating elements of appropriate shape (preferably “U” shape) with a minimum heating zone of 100 mm to be provided.
- 2.3. Minimum of 4 units of heating elements to be provided for the uniform heating.
- 2.4. The power requirement of the heating system should be of 4 kW (or more).
- 2.5. Heating system should reach a maximum temperature of 1600 °C (or more).
- 2.6. The heating element ramping up rate should be programmable; it should have rapid heating upto 10 deg C /minute (or more).

3. MICROWAVE HEATING SYSTEM

- 3.1. The source of microwave generation should be a magnetron.

- 3.2. Minimum of four number of magnetrons to be provided for uniform heating of the sample.
- 3.3. The power requirement of each magnetron should be of 1 kW (or more).
- 3.4. Microwave heating system should operate under standard frequency of 2.45 GHz, single phase/AC.
- 3.5. Heating system should reach a maximum temperature of 1600 °C (or more).
- 3.6. The heating element ramping up rate should be programmable; it should have rapid heating 10 to 20 deg C /minute (or more).

4. PRESSING SYSTEM

- 4.1. A hydraulically (preferably) controlled pressing system should be provided at a desired pressure inside the furnace chamber.
- 4.2. The overall force for the press and the cylinder should be 25 Ton-force or equivalent.
- 4.3. The operating capacity of the press should be 20 ton (or more).
- 4.4. The pressing frame should be mounted on 4 rigid posts to align upper and lower ram.
- 4.5. Both rams (anvil/piston) should be adequately water cooled to withstand the temperature, properly sealed and leak tight for high temperature operation.
- 4.6. Total ram displacement under pressure should be 100 mm or more.
- 4.7. Ram displacement speed should be up to 2 mm/s at maximum force.
- 4.8. Pressure gauge should be provided for observing instantaneous compaction pressure.
- 4.9. The system should have the safety devices are Emergency stop, warning alarm for safe operation.

5. VACUUM CHAMBER AND VACUUM PUMPING UNIT

- 5.1. The vacuum chamber should be capable to long holding of minimum desired Vacuum of 10^{-2} mbar and as high as 10^{-4} mbar.

- 5.2. Safety devices/Interlocks: The unit should have safety devices/interlocks for the safety of the machine/operator.
- 5.3. Suitable pump should be provided to accommodate the vacuum level of 10^{-2} mbar in the tender. Also the budget for suitable pumps has to be provided to accommodate the vacuum level of 10^{-4} mbar as optional.

6. WATER CIRCULATION SYSTEM

- 6.1. A water circulating system connection to different parts should be provided for safe operation of the system.
- 6.2. The working temperature range should be $5-20^{\circ}\text{C} \pm 1\%$
- 6.3. Water flow rate of min 100 lit/min (or more) to be used for circulation system.
- 6.4. Temperature indicator should be provided for visual monitoring of temperature and pressure of cooled water.
- 6.5. Safety flow interlock sensors on critical water circuits to be provided.

7. CONTROL AND INSTRUMENTATION

The input power (voltage and current), vacuum level, hydraulic press, closed cycle water circulation system and all safety interlocks should be controlled through the control console. The complete operation should be manually operated as well as automated through PC using proper application software.

8. TEMPERATURE MEASUREMENT AND CONTROL:

- 8.1. Temperature should be monitored at various places of the system using appropriate temperature measuring device. The observed temperature should be interfaced with PC to record.
- 8.2. At least one of the temperature measurements should be very close (within 5 mm) to the centre axis of the sample. should be provided.
- 8.3. Provision should be made to measure temperature at other places such as anvil and piston using appropriate thermocouples.

9. AUTOMATED DATA ACQUISITION SYSTEM

The complete system should have all its operations controlled manually as well as through a PC. The PC should have latest configuration such that all operations and data acquisitions can be done without any hindrance.

The PC also should have following accessories:

- i. DVD writer, ii) LCD flat panel screen of minimum 21 inch, iii) Graphic cards (NVIDIA-V, equivalent or better version) for image processing and v) Additional ports (min. 3 nos.) for attachment for other devices.
- The software should be compatible with the latest versions of windows operating system. Up-gradation of software should be free for atleast 5 years.
- The data acquisition system should record, save and display the following quantity as a function of time: Force, ram/piston position, temperature, vacuum (chamber pressure), voltage and amperage.

10. TOOLING

10.1. Mould sets:

One set of mould consists of die and punch. The mould sets should be provided to obtain the following sintered specimen sizes:

- i. High density graphite mould set for specimen size of $\text{Ø } 10 \times 20 \text{ mm}$ - 2 sets
- ii. High density graphite mould set for specimen size of 10 mm (Thickness) x 20 mm x 30 mm - 2 sets
- iii. High density graphite mould set for specimen size of $\text{Ø } 30 \times 40 \text{ mm}$ - 2 sets
- iv. High density graphite mould set for specimen size of 20 mm (Thickness) x 30 mm x 40 mm - 4 sets.
- v. Tungsten carbide mould set for specimen size of $\text{Ø } 30 \times 40 \text{ mm}$ - 2 sets

Detailed drawing of the mould sets for different dimensions should be provided along with the quotation.

10.2. Spacer sets:

- i. Set of graphite spacer for different dimensions of graphite mould sets - 1 No.
- ii. Set of WC spacer for different dimensions of WC mould sets - 1 No.

11. SPARES

The equipment should be supplied along with the necessary spare parts for smooth operation over a period of three years. The spare parts should consist of:

- i. 3 sets of thermocouples.
- ii. 3 sets of carbon papers and carbon felts.
- iii. 2 sets of 'O' rings for all required places.
- iv. 2 nos. of mould releasing reagents/spray.

The vendor may specify additional spares required for smooth operation of the unit over a period of five years.

12. PRE-INSTALLATION REQUIREMENTS:

The infrastructure/utilities such as power, water, compressed air and any other special ambient conditions required from this laboratory should be intimated.

13. DOCUMENTATION:

13.1 Two sets of instruction and service manuals in English including various sub systems, spares, accessories, electronic drawings, schematics drawings, PLC diagram etc. should be supplied along with the unit. The necessary software in CD has to be supplied.

13.2 It is mandatory to submit the filled Technical Compliance Sheet attached herewith along with the technical quotation.

14. OTHER MANDATORY TERMS AND CONDITIONS

- 14.1. Warranty for 24 months from the date of installation/commissioning.
- 14.2. Offer for 3 years AMC after the warranty period clearly indicating the scope of the AMC must be quoted separately.
- 14.3. The vendor/firm must have supplied any kind of microwave processing unit to at least two IITs or three NITs or four government organizations (**necessary document proof to be attached**).
- 14.4. The supplier must provide the detailed address of the customers from IITs, NITs and government R& D laboratories in India to whom they have supplied any kind of microwave processing unit.
- 14.5. Installation should be done by factory trained engineers at our institute, free of charge.
- 14.6. Operation, service and maintenance training should be provided to at least five persons for a minimum of two days.
- 14.7. Sample for training must be provided by the supplier
- 14.8. One set of maintenance and operating manuals in English (with a hard copy).
- 14.9. The offer should be made @ 5 % GST against a concessional GST certificate.
- 14.10. Equipment to be delivered in test ready, factory calibrated condition.
- 14.11. Attractive discount for an educational institution should be offered.
- 14.12. Support of hardware and spares for 10 years and more after the End of life of the model

- 14.13. The firm should be equipped with well-trained engineers to offer post warranty maintenance and service support.
- 14.14. An optional budget should be provided for 0.01mm (minimum) of digital readout for Z axis position display.