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Technical Specification for Spark Plasma Sintering (SPS) Furnace
RFX No. : 6100000699 (Reference No. 1000018824)

The requirement is of a **spark plasma sintering (SPS) furnace**, which is a **field assisted sintering technique (FAST)**, which can be used to obtain near-theoretical density in difficult-to-sinter ceramic and metallic materials, as well as allow diffusion bonding, by simultaneous applications of heat, uniaxial pressure and pulsed direct current. Further detailing of the (mandatory) required specifications are provided in the following.

1. Sintering pressure: 100 kN force, facilitated by vertical axis hydraulic pressure system.
2. Maximum temperature: 2500 °C, and continuous operation at up to 2400 °C.
3. Dual temperature detection system:
 - 3.1. Radiation thermometer (pyrometer) system. Minimum temperature 600 °C or less, with capability of detecting up to 2800 °C or higher.
 - 3.2. K-type thermocouple for lower temperatures; but capable of precise measurement up to 1000 °C or higher.
4. DC Pulse Generator;
 - 4.1. On time pulse duration range: Minimum ~3 ms or shorter, maximum up to 300 ms or longer.
 - 4.2. Off time pulse duration range: Minimum ~3 ms or shorter, maximum up to 30 ms or longer.
5. Output current up to 5000 A and output voltage up to 10 V.
6. Overall operation and control: Manual, and Automatic with PID Digital Programmable Temperature Controller.
7. Precise positioning of pyrometer (and thermocouple) for detecting temperature on the surface of the die is required.
8. Sintering atmosphere: possibility of using inert gas, vacuum and air.
9. Rotary pump based vacuum system is needed, such that evacuation can be done from atmospheric pressure to $\sim 5 \times 10^{-2}$ torr or better.
10. High vacuum system with diffusion pump; vacuum limit 5×10^{-5} torr or better.

11. Vacuum meters: pirani pressure gauge, plus-minus bourdon pressure gauge, Penning gauge.
12. Needed stainless steel (SS 304 or equivalent) vacuum chamber, with provision of a water-cooled jacket.
13. Water-cooling system for pressing rams and furnace chamber.
14. An appropriate cooling water circulation system (chiller). Cooling capacity should be quoted in kW. Compatible with Indian power supply standards.
15. Vacuum/sintering chamber should have quartz glass viewing windows, with protection plates.
16. PID digital programming for temperature and pressure control.
17. Z-axis displacement meter, with a least count of 10 micrometres or smaller.
18. Data acquisition system to record SPS current, voltage, temperature, pressure, vacuum and displacement throughout the cycle.
19. Safety measures such as overcurrent detection, water temperature and flowrate detection, overcurrent protection, emergency stop button and warning alarm system.
20. Most of the operations, programming and display (such as control/setting of power supply, vacuum, pressure, temperature, temperature and displays of vacuum, temperature, pressure, current, voltage, displacement, warning etc.) should be facilitated by touch panel and digital display.
21. It should be possible to view the above data and sintering related data (such as, temperature, pressure, displacement, current, voltage, vacuum etc.), in real time, on a PC via USB connectivity.
22. Electrical power system compatible with 3-phase, 415 V power supply available in India.
23. Piston stroke up to 100 mm or higher
24. All computer software should be compatible with Microsoft Windows 10 operating system.
25. Moulds (dies) and punches made of high-density graphite with maximum temperature 2200°C or higher, and 60 MPa uniaxial pressure capability at this high temperature.
 - 25.1. Dies for WORKPIECE (SPECIMEN) DIAMETERS of ~10 mm (10 pieces), ~12.7 mm (10 pieces), ~15 mm (10 pieces), and ~30 mm (10 pieces).
 - 25.2. Compatible punches
 - 25.3. Connection pieces, spacers and alignment pieces/tools should be included
 - 25.4. Graphite foil, 1 square metre or more, compatible with the die-punch set.
26. Moulds (dies) and punches made of tungsten carbide usable up to 900°C or higher
 - 26.1. Dies for WORKPIECE (SPECIMEN) DIAMETERS of ~10 mm, ~12.7 mm, ~15 mm, and ~ 30 mm (1 piece each).
 - 26.2. Compatible punches
 - 26.3. Connection pieces, spacers and alignment pieces/tools should be included
27. Compatible tool set should be included.
28. Detailed operating manual should be included.

29. All the controls, indicators, software, labels, markings, manuals, etc. should be in English language.

Other requirements:

1. The vendor should have supplied spark plasma sintering unit(s) to an organisation in India and Installation report should be submitted along with the technical bid.
2. List of existing customers with contact details should be submitted along with the technical bid.
3. Warranty: Comprehensive warranty of 2 years from the date of installation.