Microwave (Synthesis) System Specifications

The microwave system including refluxing and dry media synthesis capability is intended for in-organic metal, ceramic and semiconductor nanomaterials synthesis at medium/ elevated pressure and temperature.

S. No.	Parameters	Specifications
1.	**Microwave power**	• Single or dual magnetrons with power delivery of 1500 W or higher, with capability to increment the selected power from 1-100% or in 1 W step. Details to be provided. • Should have magnetron protection device. Details to be provided. • Should have waveguide for uniform distribution of microwaves into the cavity. Details to be provided.
2.	**High-pressure & temperature vessels**	• Vessels should be resistant to all solvent & acidic environments • Number of vessels: Minimum 10 • Minimum capacity per vessel: 100 ml • Maximum sustainable vessel pressure: 100 bar • Maximum sustainable vessel temperature: 250^{o} C and higher • Material: TFM/PTFE/ Quartz or any appropriate material which is acid resistant and capable of with standing required temperature and pressure. • Should provide appropriate tools to close the vessels. Details to be provided. • Should have suitable provision/rotors to process single vessel as well as 10 vessels simultaneously.
3.	**Open vessel synthesis using reflux**	• Kit for batch synthesis at normal pressure using 500 ml round bottom glass flask with all required accessories including adapter and condenser, aluminum case and PTFE and Weflon stirring bars. Details to be provided.
4.	**Temperature controls/ sensors**	• Should have appropriate in-situ temperature (Thermocouple / Fiber Optics or suitable) sensors/controls. Details to be provided. • Sensors should accurately measure temperature of all vessels using IR or suitable sensor when group of vessels are placed for processing.
5.	**Pressure controls/ sensors**	• Should have appropriate in-situ pressure sensor/controls. Details to be provided. • Pressure sensor should have the capability to measure the variations in pressure and provide feedback to control the exothermic reactions. Details to be provided.
6.	**Magnetic stirring**	• Should have the capability for stirring of solvents in all the 10 vessels simultaneously during processing. • Magnetic stirrers for polar and non-polar solvents to be quoted.
7.	**Internal Self diagnosis**	• The microwave system should have adequate internal self diagnostic arrangement. Details should be provided.

	arrangement & safety locks	• Safety interlocks to prevent microwave emissions with opening of door. Details to be provided.
8.	**Interior cavity**	• Acid fume resistant high grade steel with fluoro-polymer or appropriate material coated. Details to be provided. • Should have cooling mechanism for cooling of microwave cavity and vessels without any water circulation. Details to be provided.
9.	**Exhaust**	Should have the provision to exhaust the fumes etc. Details to be provided.
10.	**Exhaust connectors**	Should provide acid resistant flexible hose connectors to lab exhaust. Details to be provided.

11.	**Software/ Programming capability**	Should have adequate provision for programming the following parameters (details should be provided)
		  • Microwave power in increments of 1-100% or in 1W steps of the total power
		  • Pressure
		  • Time at control pressure
		  • Total run time
		• System software should allow for automatic adjustment of power delivery based upon sample load and preprogrammed control settings.
		• Provision to monitor the various parameters including power, temperature, ramp and time.
		• Should be able to generate various plots of the process parameters.
		• Should have the ability to save methods and runs on a windows-formatted flash card/ USB
		• Flash card and USB with minimum 4 GB capacity should be provided
		• Periodic software updates should be provided free of cost
		• **Reinstallation CD's:** CDs containing all the reinstallation software and manuals to be provided

12.	**Display**	Appropriate display capable to display the detailed methods, graphs of temperature and pressure against time and temperature of individual vessels. Details to be provided.
13.	**Stainless steel door**	Stainless steel door with shatter – proof glass window. Details should be provided.
14.	**Hardware protection**	Should have polymer/ appropriate material coating both inside and outside surfaces to protect against acid/organic solvents. Details to be provided.
13.	**Power**	240 ± 10 V, 50 Hz, details of receptacle/socket to be provided
14.	**Guarantee/ Warranty**	• The entire equipment should be guaranteed for a period of 2 years from the date of commissioning. During warranty period, if there is any repair to be carried out at the supplier's works, transportation cost of equipment/component besides repair / replacement charges, if any, should be borne by the supplier.

		• AMC charges for 3 years beyond the warranty period of 2 years should be quoted
15	**Qualification Criteria & Other Aspects**	• The vendor should have supplied minimum two systems in India and details should be furnished. • Should have agents in India to provide after sales service, support and maintenance • Photographs and catalogues related to every item of machine should be enclosed at the time of supplying the system • Dimensions of equipment, weight and space requirements should be submitted in technical offer. • Installation & Commissioning should be carried out at BHEL R&D. Pre-installation requirements should be furnished • Commissioning charges, if any, to be indicated • Two hard copies of all the operational manuals related to the system have to be provided while supplying the system. • The supplier should certify the availability of spares for a minimum period of 10 years from the date of system commissioning
16	**Training**	All the expenses related to training for one BHEL engineer at supplier's works to be provided. (For BHEL engineer travel expenses including boarding and lodging will be borne by BHEL)
17	**Compliance Statement**	Compliance statement of specification to be submitted along with the offer. Failure to give compliance statement, the offer is liable to be rejected. All tender specifications to be compared with machine offered line by line and documentary evidence must be enclosed by the supplier along with quotation
18.	**Spares**	Price of essential spares and consumables should be provided
19.	**Technical & Commercial bid submission**	1. Technical offer with all catalogues should be provided 2. Compliance statement meeting the specification line by line should be provided (Failure to give compliance statement, the offer is liable to be rejected) 3. **Commercial bid with terms and conditions to be submitted in a separate sealed cover**

A. After the system delivery to BHEL R & D, if the system is installed in existing R & D building and later if it has to be shifted to the new building (Center for Nanotechnology and Applications) this has to be done by the supplier and related expenses should be specified. The shifting will be within 9 months of initial installation

B. Delivery: The equipment should be delivered within 3-4 months from the date of placement of purchase order

Note: All covers should be clearly marked indicating the contents and should be SEALED.

Compliance Statement (To be accordingly filled by supplier)

The microwave system including refluxing and dry media synthesis capability is intended for in-organic metal, ceramic and semiconductor nanomaterials synthesis at medium/ elevated pressure and temperature.

S. No.	Parameters	Specifications	Offered System Specifications/Remarks
1.	**Microwave power**	• Single or dual magnetrons with power delivery of 1500 W or higher, with capability to increment the selected power from 1-100% or in 1 W step. Details to be provided. • Should have magnetron protection device. Details to be provided. • Should have waveguide for uniform distribution of microwaves into the cavity. Details to be provided.	
2.	**High-pressure & temperature vessels**	• Vessels should be resistant to all solvent & acidic environments • Number of vessels: Minimum 10 • Minimum capacity per vessel: 100 ml • Maximum sustainable vessel pressure: 100 bar • Maximum sustainable vessel temperature: 250^{o} C and higher • Material: TFM/PTFE/ Quartz or any appropriate material which is acid resistant and capable of with standing required temperature and pressure. • Should provide appropriate tools to close the vessels. Details to be provided. • Should have suitable provision/rotors to process single vessel as well as 10 vessels simultaneously.	
3.	**Open vessel synthesis using reflux**	• Kit for batch synthesis at normal pressure using 500 ml round bottom glass flask with all required accessories including adapter and condenser, aluminum case and PTFE and Weflon stirring bars. Details to be provided.	
4.	**Temperature controls/ sensors**	• Should have appropriate in-situ temperature (Thermocouple / Fiber Optics or suitable) sensors/controls. Details to be provided.	

		• Sensors should accurately measure temperature of all vessels using IR or suitable sensor when group of vessels are placed for processing.	
5.	**Pressure controls/ sensors**	• Should have appropriate in-situ pressure sensor/controls. Details to be provided. • Pressure sensor should have the capability to measure the variations in pressure and provide feedback to control the exothermic reactions. Details to be provided.	
6.	**Magnetic stirring**	• Should have the capability for stirring of solvents in all the 10 vessels simultaneously during processing. • Magnetic stirrers for polar and non-polar solvents to be quoted.	
7.	**Internal Self diagnosis arrangement & safety locks**	• The microwave system should have adequate internal self diagnostic arrangement. Details should be provided. • Safety interlocks to prevent microwave emissions with opening of door. Details to be provided.	
8.	**Interior cavity**	• Acid fume resistant high grade steel with fluoro-polymer or appropriate material coated. Details to be provided. • Should have cooling mechanism for cooling of microwave cavity and vessels without any water circulation. Details to be provided.	
9.	**Exhaust**	Should have the provision to exhaust the fumes etc. Details to be provided.	
10.	**Exhaust connectors**	Should provide acid resistant flexible hose connectors to lab exhaust. Details to be provided.	
11.	**Software/ Programming capability**	Should have adequate provision for programming the following parameters (details should be provided) • Microwave power in increments of 1-100% or in 1W steps of the total power • Pressure • Time at control pressure • Total run time	

		• System software should allow for automatic adjustment of power delivery based upon sample load and preprogrammed control settings. • Provision to monitor the various parameters including power, temperature, ramp and time. • Should be able to generate various plots of the process parameters. • Should have the ability to save methods and runs on a windows-formatted flash card/ USB • Flash card and USB with minimum 4 GB capacity should be provided • Periodic software updates should be provided free of cost • **Reinstallation CD's:** CDs containing all the reinstallation software and manuals to be provided	
12.	**Display**	Appropriate display capable to display the detailed methods, graphs of temperature and pressure against time and temperature of individual vessels. Details to be provided.	
13.	**Stainless steel door**	Stainless steel door with shatter – proof glass window. Details should be provided.	
14.	**Hardware protection**	Should have polymer/ appropriate material coating both inside and outside surfaces to protect against acid/organic solvents. Details to be provided.	
13.	**Power**	240 ± 10 V, 50 Hz, details of receptacle to be provided	
14.	**Guarantee/ Warranty**	• The entire equipment should be guaranteed for a period of 2 years from the date of commissioning. During warranty period, if there is any repair to be carried out at the supplier's works, transportation cost of equipment/component besides repair / replacement charges, if any, should be borne by the supplier. • AMC charges for 3 years beyond the warranty period of 2 years should be quoted	

15	**Qualification Criteria & Other Aspects**	• The vendor should have supplied minimum two systems in India and details should be furnished. • Should have agents in India to provide after sales service, support and maintenance • Photographs and catalogues related to every item of machine should be enclosed at the time of supplying the system • Dimensions of equipment, weight and space requirements should be submitted in technical offer. • Installation & Commissioning should be carried out at BHEL R&D. Pre-installation requirements should be furnished • Commissioning charges, if any, to be indicated • Two hard copies of all the operational manuals related to the system have to be provided while supplying the system. • The supplier should certify the availability of spares for a minimum period of 10 years from the date of system commissioning	
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A. After the system delivery to BHEL R & D, if the system is installed in existing R & D building and later if it has to be shifted to the new building (Center for Nanotechnology and Applications) this has to be done by the supplier and related expenses should be specified. The shifting will be within 9 months of initial installation **B. Delivery:** The equipment should be delivered within 3-4 months from the date of placement of purchase order **Note: All covers should be clearly marked indicating the contents and should be SEALED.**	