Technical Specifications of
Horizontal, Single Stack, High Temperature Diffusion Furnace

Function: Diffusion of n-type impurities in crystalline silicon wafers (125 & 156 mm square) with automatic loading and unloading.

Item Description	Important Features	Quantity
1. Furnace proper	Horizontal furnace with a single quartz process tube with a minimum diameter of 280/290 mm for the following process: Phosphorus diffusion of 0.20-0.25 mm thick, diagonally loaded (singly or back-to-back), 125 mm Sq. / 156 mm Sq. silicon wafers for a minimum batch size of 50 wafers using liquid dopant source (Phosphorus oxychloride, $POCl_3$) The furnace body to have two blank slots to be populated later with heating elements and quartz tubes of the same size. The principal components are as follows: Heating element: 3-zone, Kanthal A1 wire or equivalent, with or without tube support and with tube adapters to provide minimum heat loss, minimum process tube/ scavenger leakage and concentric location of the process tube. Thermocouples: Double R or S type 'spike' thermocouples (without compensation wire and with high purity insulators) for temperature control as well as over- temperature protection. 3-point profiling thermocouple inside process tube for in-situ, real time temperature profiling. Temperature controller: Digital temperature controller with fuzzy enhanced PID (cascade) control / DDC controller. Scavenger box: At the load end of the tube with independent exhaust damper control; made out of heavy-duty electro-polished steel; with high temperature sealing at the mating surface with the furnace for minimizing leakage of process gases. Cooling system: Water-cooled heat exchanger mounted on top of the furnace. Also provision for emergency cooling based on free convection cooling. Temperature range: 600 – 1100 deg C. Temperature flat zone: 300 mm (min.) to process batches of 50 wafers at a time. Operating temperature: ± 1 °C up to 600 °C (min.) accuracy ± 0.5 °C above 600 °C	1 pc.

2. Gas delivery system	**Gas manifold system comprising arrangement for flow of N_2, N_2 carrier and O_2 gases for phosphorus diffusion from a liquid dopant source ($POCl_3$).** **All 3 process gas lines to be fitted with individual mass flow controller (soft start), pressure gauge, gas regulator, in-line filters (for 0.05 micron particle retention or better), manual diaphragm shut off valve, pneumatically controlled gas valves, check valves and other related accessories for all gases.** **Gas inlet assemblies consisting of ¼" MVCR fitting, regulator, gauge filter and manifold drop with manual diaphragm shut-off valve to tube level; to be made of 316 L stainless steel, electro-polished tubing with orbital welding, no bending and VCR fittings.** **Gas system leak integrity of 10^{-8} cc/sec He or better.**	**1 pc.**
3. Bubbler assembly	**Bubbler assembly with Teflon valves and tubing for 1.5 l, round-bottomed quartz flask for $POCl_3$ and automatic temperature controller for accurate control of dopant temperature. (Quartz bottle containing the liquid dopant is within BHEL's scope of supply)**	**1 pc.**
4. Load station	**Automatic loading and unloading of wafers with soft contact loading/ soft landing system (speed control: 10-100 mm/min.) with a PC based controller and display.** **Vertical laminar flow station of Class 100 housing the loading/ unloading system with blowers mounted in the base of the load station and foldable plexi glass shutter.**	**1 pc.**
5. Exhaust system	**To be fitted with the scavenger at the loading end.** **Exhaust duct to be fitted with heavy-duty, 100 mm dia, electro-polished stainless steel.** **Rear exhaust system for process gases with dynamic and accurate (-50 to + 50 pa), closed loop atmospheric pressure control within the tube.**	**1 pc.**
6. Quartzware	**Quartz process tube for 156 mm sq. wafers with ball joint for gas inlet and profiling thermocouple.** **Quartz process boats for 125 and 156 mm sq. wafers.** **Quartz tube closer for soft landing.** **Quartz tube for rear exhaust of process gases.** **Quartz boat pick-up fork.** **Quartz heat barrier, flow baffle for process gas.**	**1 pc.** **2 pcs.** **1 pc.** **1 pc.** **2 pcs.** **1 pc.**
7. Process control requirements	**Phosphorus diffusion from a liquid source ($POCl_3$) of 125/ 156 mm wafers at process temperatures of 800 – 950 °C.** **Variation in sheet resistivity: ± 3% or better across a wafer, wafer-to-wafer or batch-to-batch for sheet resistivity in the range of 30 to 80 Ohms / sq.** **Accurate and precise control on a continuous basis from a computer terminal of complete process**	

	control for auto temperature profiling, boat loading speed, boat loader position, recipe steps, recipe times, process pressure control, gas flow and ramp rates, monitoring of process conditions etc. Software for plotting of batch data and analysis. **Setting of all relevant process parameters from a touch-screen control panel placed at the tail end of the loading station while facing the furnace tube. (Pl. see the attached sketch)**	
8. Safety features	**Built-in safety features including the following:** • **Over temperature protection and control (automatic breaker trip)** • **Indication for failure of cooling water** • **Indication for failure of exhaust** • **EPO on each of these failures with audio-visual alarm.**	
9. Commercial terms	**Operation & maintenance manual (soft as well as hard copies).** **List of customers worldwide with specific mention of customers in India using similar equipment for at least 1 year.** **Guarantee of the equipment and process for at least one year.**	**2 copies**
10. Training & installation	**Installation and commissioning of the equipment at BHEL ASSCP.** **Demonstration of the process at BHEL ASSCP meeting the process criteria as mentioned above.** **Training of BHEL personnel on complete operation and maintenance of the equipment at BHEL ASSCP.**	
11. Input power supply	**3 phase, 380 to 420 VAC, Frequency: 50 Hz.**	

For any technical clarification please contact –

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Top view (not to scale) of the tentative location of the diffusion furnace in the process area