	INDIAN INSTITUTE OF TECHNOLOGY BOMBAY **MATERIALS MANAGEMENT DIVISION** **Powai, Mumbai 400076.**

Ref No.(PR No. 1000051152) **(Rfx No.6100002482)**

Technical Specifications : MOCVD growth system
(Qty : 1)

Sr. No	Item Description	Detailed Technical Specification	Technical Compliance (Yes / No)	Additional Information (if any)
1	**MOCVD growth system** The MOCVD growth system must include the following components and specifications.			
1.1	Growth Chamber	a. Stainless steel (SS 316L) chamber with active temperature control i. room temperature to 60°C during growth ii. periodically bake the chamber out at temperatures up to 230°C to remove Se and S from inner surfaces. b. Background pressure of 10^{-3} Torr, 10^{-5} Torr is preferred. c. A plasma cleaner that can be used for chamber cleaning. The cleaner must be isolated when not in use to avoid contamination during growth. d. Showerhead or concentric ports at the top of the chamber for the inlet of two gas streams, such that the metal and chalcogen precursors mix only after entering the growth chamber. No pre-mixing must be allowed. i. The showerhead and substrate separation must be varied controllably.		

		e. Resistance heater or inductively coupled susceptor capable of uniformly heating at least 3” diameter substrate up to 1100^{o}C with rotation (up to at least 250 rpm) i. In case of metal/alloy-based heaters, the heating assembly must be enclosed to minimize reaction with precursors. ii. Graphite coated with SiC is preferred for such isolation. If any other materials are used, compatibility testing is needed. f. Quartz liner tubes/plates that can be swapped out periodically for chamber cleaning g. Pressure measurement and control system capable of maintaining the chamber at pressures ranging from 10 torr to 1000 torr with gas flow. h. Exhaust ports with pressure release valves for emergencies. Emergency release valve should be connected to the exhaust for mitigation.		
1.2	<u>Downstream Exhaust</u>	a. Vacuum pump for corrosive gases capable of maintaining desired pressures under a flow rate of up to 50 slpm. b. Filter to collect Se and S particulates upstream of the pump. Design should allow for easy replacement of the filter. c. Oil filtration system and downstream mist filter for the pump.		
1.3	<u>Gas Panel</u>	a. Comprised of metal gasket sealed fittings, welded 316L stainless steel tubing, silver-free gaskets, filters and non-return valves where necessary. b. High purity pneumatic and manual valves, mass flow controllers and pressure controllers rated for the required precursors. c. Pressure-controlled vent/run manifold for two separate gas source lines (metal precursors and chalcogen precursors), each having a capacity to connect 6 precursors. d. Set up for use with N_2, H_2 or a mixture of the two as carrier gases. e. Four gas source lines (H_2Se, H_2S, 2 spares) f. One gas line for HCl for reactor cleaning		

		g. Separate bank for N_2 MFCs for exhaust dilution for a maximum flow of 60 slm to be connected after the pump. h. ½ inch exhaust tubings are needed to connect to a dry scrubber i. Four moderate temperature (-10^oC to 50^oC) metalorganic source bubbler manifolds for metal precursors ($W(CO)_6$, $Mo(CO)_6$, two spares). Two of these bubbler manifolds should include dilution capabilities. j. Two high temperature (25^oC to 200^oC) metalorganic source bubbler manifolds for low vapour pressure precursors. k. Associated heating tapes and temperature controllers for all the lines at the respective temperatures, 30-60°C for low temperature precursors and 50- 200°C for high temperature sources. l. Constant temperature baths (chillers) for 4 bubbler sources m. Compact heaters for high temperature precursors		
1.4	<u>Safety and interlock system</u>	a. The growth chamber and gas manifold should be enclosed in a vented chamber. b. A He leak test system so that the entire system till the exhaust can be easily leak tested. c. Integrated toxic gas detection system for H_2Se and H_2S. The sensors will be covered by IITB, but integration needs to be planned for. d. Inlet gas pressure sensors, H_2 sensor, ventilation sensor, reactor overpressure sensor to be provided. e. The function of each sensor is given below and must satisfy these requirements: f. Inlet gas pressure – this is an inline gauge that can provide an electrical signal if the pressure of N_2/H_2 drops below 40-50 psi for proper operation of the MFCs and PCs.		

		g. H_2 sensor – measures H_2 concentration in the vented enclosure in the event of a system leak. It will shut down everything, especially the furnace and start a purge sequence. h. Ventilation sensor – Measures the flow rate of the gas in the duct provided for ventilation. For proper operation, we maintain 800 SCFM in a vented enclosure with the growth chamber. If it is too low, it is a risk in case of any leaks. i. Reactor over-pressure sensor will be used to initiate the emergency release valve connected to the exhaust. j. Interlock system for above sensors with automatic system shutdown k. Growth and transfer chamber should be interlocked.		
1.5	<u>Automated control system</u>	a. LabView type control system for remote operation of all valves, mass flow controller, pressure controllers, system temperature and pressure b. Recipe maker for creation of multi-step processes c. User can configure ranges of MFCs & pressure controllers d. Operation in manual or recipe mode e. Integrated with the interlock system for safe system operation		
1.6	<u>Wafer loading and unloading without ambient exposure</u>	a. Wafer loading/unloading with a vacuum interface for a wafer up to 4 inches, which prevents ambient exposure. b. Transfer chamber that can connect the growth chamber and has the possibility of connecting to other characterisation tools housed inside a glove box. c. Robotic arm that can navigate automatically between chambers. d. The transfer chamber valves are configured such that transfer is possible only when a certain pressure is reached and both the chambers are at the same pressure. e. A reliable wafer-lift mechanism must be incorporated for ease of transfer.		

1.7	Evidence of uniform growth over inch-scale substrates	a. The growth conditions like temperature, pressure, flow of metal hexacarbonyl and liquid/gaseous chalcogen precursors should be included. Solid precursors used for growth are not acceptable. b. Chamber specifics used for the inch-scale should be provided. c. Uniformity data in terms of Raman/PL and morphology should be submitted. d. MoS_2 and WS_2 samples must be provided for characterization in IITB.		
1.8	Warranty of the system	1 year from installation for all the parts		