



INDIAN INSTITUTE OF TECHNOLOGY BOMBAY

MATERIALS MANAGEMENT DIVISION

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Technical Requirements for Micromechanical Testing Equipment (Qty: - 01)

It is intended to procure a highly versatile and sophisticated horizontal servo-hydraulic micromechanical testing equipment capable of testing a wide range of materials such as metals, ceramics, polymers, semiconductor devices, nanocomposites, thin films, and biomaterials at different length scales ranging from tens of micrometers to millimeters. Furthermore, the horizontal testing system should be compact with all the necessary accessories so that it can be used for testing the materials under different environments and temperatures up to 1300 °C under both static and dynamic (fatigue) loading conditions. In addition, the equipment should be supplied with a video extensometer along with digital image correlation that facilitates in-situ full-field strain mapping required for understanding deformation micromechanisms in miniature specimens with accurate measurements of elastic and plastic properties of ductile and brittle materials. Supply, installation and performance demonstration of the horizontal testing machine with necessary hardware and software should meet the following specifications:

1. Load Frame

Sr. No	Particular	Compliance (Yes/No)	Additional Info if any
1.1	The load frame shall be horizontally mounted, shall be of fatigue rated two column self-reacting type with ± 10 kN static and ± 8 kN dynamic capacity.		
1.2	The frame should be tilted at a certain angle so that it will be easy to reach to the grips while installing the specimen.		
1.3	Actuator to be mounted on non-moving crosshead.		
1.4	Total minimum daylight between 10 kN grips mounted on moving crosshead and fixed base shall be 350 mm or more.		
1.5	Space between columns shall be 350 mm or more.		
1.6	Overall height of the machine should not be more than 1800 mm.		
1.7	Overall dimension of the frame, shall not exceed W 600 mm x D 500 mm x L 2000 mm and weight not exceeding 600 kgs (frame alone).		
1.8	The column diameter should be 60 mm or more, so that the minimum frame stiffness shall be 100 kN/mm or higher when the distance between the top of the actuator piston and to		

	base of the load cell is about 400 mm.		
1.9	It shall have a load frame mounted handset, with various functions as mentioned in point number 6 below.		
1.10	Anti-rotation assembly shall be provided.		
1.11	The machine should be CE-compliant.		
1.12	The system should be supplied with a heavy load-bearing table of W 900 mm x H 900 mm x L 2500 mm or more for mounting the machine.		

2. Servo Hydraulic Actuator and Manifold

Sr. No	Particular	Compliance (Yes/No)	Additional Info if any
2.1	The actuator should be a double-ended, equal-area linear actuator with hydrostatic bearings for the best friction-free static and dynamic performance.		
2.2	The actuator should be a bolt-on actuator mounted on the fixed base of the frame.		
2.3	The actuator should be of ± 8 kN Fatigue rated dynamic capacity, with ± 50 mm (total 100 mm) displacement /stroke or better.		
2.4	Coaxially mounted full stroke linear variable displacement transducer (LVDT) for measurement and control of actuator displacement, with a resolution of 0.001 mm or as per ASTM E2309 or better.		
2.5	Low friction and wear-resistant and high side load of 40% of full-scale load-carrying capabilities.		
2.6	The actuator should provide performance as ± 50 mm at 1 Hz and ± 6.0 mm or more at 80% of the load capacity of the actuator.		
2.7	A suitable flow rate servo valve (not proportional valves) shall be provided for conducting tests mentioned above.		
2.8	Manifold for one two-stage flow control servo valve with a total flow of 10 lpm or more to be provided.		

2.9	Operating pressure: 280 bar or better		
2.10	Operating temperature: preferably 40-50 °C where the actuator shall stop at high oil temperature interlock to protect the power pack, hydraulic oil, machine and to guarantee the performance of the system in the long run.		

3.Load Cells

Sr. No	Particular	Compliance (Yes/No)	Additional Info if any
3.1	±10 kN dynamic capacity fatigue rated load cell. Additional load cell of 1 kN capacity to be offered.		
3.2	300% overload capacity		
3.3	Accuracy class-0.02		
3.4	Linear error and Hysteresis should be less than ±0.04%		
3.5	Fatigue life minimum one billion cycles		
3.6	Full range calibration (traceable to NIST/NABL/equivalent International Standards)		
3.7	All adapters for load cells compatible with the actuator, load frame and grips shall be provided.		

4.Control Electronics

	Particular	Compliance (Yes/No)	Additional Info if any
4.1	Controller shall be of digital closed loop controller.		
4.2	64-bit DSP (Digital Signal Processor) with speed of 1 GHz or more.		
4.3	Controller should have provision for 12 numbers isolated digital input & output signal		
4.4	Controller should have provision for a maximum of 12 channels of high speed, high resolution sensor conditioner module.		
4.5	24-bit data acquisition on the control and feedback channels.		
4.6	Data acquisition rate of 20 kHz or higher from all channels simultaneously, shall be available.		
4.7	Internal data sampling rate of 2 MHz or more		
4.8	The controller should include three channels of sensor conditioner module for stroke, force, axial extensometer for control mode and data acquisition.		
4.9	Auto offset and digital auto-zero capability.		
4.10	Adaptive peak control		
4.11	Adaptive control and PID parameter modification & compensation of sample stiffness gradient		
4.12	The controller should have interaction of a second control loop (like deformation control in correlation with the target setting of force).		
4.13	Easy downloadable firmware for future upgradations, without making any changes in the controller.		
4.14	The controller should be capable of conducting all the tests mentioned above.		
4.15	It should be capable of acquiring data from all control and feedback channels.		

4.16	It shall be compatible with industry-standard ethernet or USB communication ports.		
4.17	User settable software safety limit interlocks on upper and lower limit readout on each of the feedback channels with individual options of Stop/Hold/Trip.		
4.18	It shall be able to run cyclic loading defined in various waveforms like ramp, sine, triangular, sawtooth, rectangle, and pulse functions.		
4.19	The system should be able to run in Stroke, Load & Strain control modes as well as any connected transducer.		

5.Remote Control Hand Set with Touch Screen LCD Display:

The remote-control handset with LCD touchscreen should offer convenient test set-up and operation of the test System. The remote control should be fully programmable. The Remote Control should offer:

Sr. No	Particular	Compliance (Yes/No)	Additional Info if any
5.1	Display of up to three (3) channels (for example, Force / Piston Stroke / Strain)		
5.2	Zeroing of control and measurement channels		
5.3	Piston or Crosshead Movement via trim function		
5.4	Adjustable piston or crosshead speed		
5.5	Unclamping of movable crossheads with crosshead positioning		
5.6	Opening and closing of hydraulic, pneumatic, or motorized grips		
5.7	Display brightness adjustment		
5.8	Rotation of display		

5.9	Integrated Emergency STOP		
5.10	Key-Switch to activate the Setup mode with reduced piston or crosshead speed and in accordance with the new CE Machine directive for testing machines or actuators.		

6. Hydraulic power pack

Sr. No	Particular	Compliance (Yes/No)	Additional Info if any
6.1	Hydraulic power pack should have a nominal oil flow capacity of 6 lpm or higher at 280 bar pressure with 415 AC, 50 Hz.		
6.2	It should have a low-noise internal gear pump with constant oil delivery.		
6.3	High energy efficient motors comply with European Standard IEC 60034-30-1 with Premium Efficiency IE3 level.		
6.4	Should be controlled through PLC (Programmable Logic Controller) with Operation Panel.		
6.5	Should have safety features to trip at over temperatures, over pressure, low oil level, filter clogging, power failure, motor overload etc.		
6.6	Should have built-in water cooled with stainless steel heat exchanger.		
6.7	Should include first fill oil for the power pack and should be filled by the vendor mineral based equivalent to DTE 25 or Servo 46 or Shell Tellus 46 AW or Mobil NUTO H46 (to be supplied),		
6.8	Should include 3-micron pressure-line oil filtration.		
6.9	Tank capacity should be a minimum 25 liters or higher.		
6.10	Hydraulic oil for the HPU to be provided.		
6.11	Hoses of a minimum of 6 m or higher length need to be provided which is sufficient to connect the machine with the power pack.		
6.12	The hydraulic power pack to be isolated through anti-vibration dampers.		
6.13	Power supply available is 415V +/-10%V, 3-Phase, 50 Hz		
6.14	Vendors should submit a performance curve along with the technical offer.		

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7. Computer and Monitor

Sr. No	Particular	Compliance (Yes/No)	Additional Info if any
7.1	A compatible desktop PC		
7.2	Processor: Intel Core i7		
7.3	Memory: RAM 16 GB and SSD 256 GB or higher		
7.4	Hard drive: minimum 1TB SATA		
7.5	On board Graphic Card		
7.6	CD-RW/DVD-ROM		
7.7	Minitower ATX		
7.8	Win 10 Pro (64 Bit) or better		
7.9	Keyboard, Mouse		
7.10	32-inch LED monitor		
7.11	Supply 230V AC 50 Hz.		

8. Static application software

8.1 Static application software: The software should be MS-WINDOWS 10/11 compatible and should run on a compatible PC. Complete machine control through software and analysis of data for all kinds of testing for tensile, compressive and flexural tests. The software should have the following features.

Sr. No	Particular	Compliance (Yes/No)	Additional Info if any
8.1.1	Standardized test method template for almost all testing standards.		
8.1.2	There should be a provision to modify the standard template to set user-defined test parameters and results.		

8.1.3	Should be able to conduct tests in any control mode as position, load, and strain control.		
8.1.4	The software should be able to determine the standard calculations and produce statistics.		
8.1.5	The software should have Auto-scale plotting in real-time XY graphs.		
8.1.6	The software should have the facility to export user-defined test raw data in CSV or ASCII format.		
8.1.7	The software should have the facility to export user-defined final test results and statistics		
8.1.8	The software should have the capability to generate the user-defined report.		

8.2 Cyclic test software

Sr. No	Particular	Compliance (Yes/No)	Additional Info if any
8.2.1	The Software should facilitate the users to define and run tests, and to acquire data for a wide range of dynamic and quasi-static applications.		
8.2.2	The software to run everything from simple ramps to dynamic & fatigue single to complex multi-axial test systems.		
8.2.3	The software should have provision for creating and editing such a test procedure made graphically using a flowchart editor.		
8.2.4	The software should have comprehensive data logging and data reduction tools, to enable the user to acquire the required data and at the same time minimize data file size through intelligent data reduction features.		
8.2.5	The software should support waveform types such as sine, triangle, square, holds, ramps, trapezoidal, user-defined turn points files, and sample data playback.		
8.2.6	The software should provide test graph(s) with a selectable axis, digital displays of the channels including actual value and upper/lower peak values, a cycle counter, set-value of the frequency and amplitude of the control channel as well as test duration.		

9. Accessories:

9.1 Mechanical Non-Shift Dynamic Wedge Grips

Sr. No	Particular	Compliance (Yes/No)	Additional Info if any
9.1.1	The grips should be manually operated at ± 10 kN capacity and should be fatigue rated.		
9.1.2	The wedge grips should be general-purpose wedge grips suitable for static, pseudo-static and dynamic (through-zero) testing.		
9.1.3	The grip should be suitable for a 10 mm diameter specimen and an 8 mm flat specimen with 25 mm width and 25 mm clamping length or more.		
9.1.4	Should have symmetrical housing design for easy change of inserts.		

Sr. No	Particular	Compliance (Yes/No)	Additional Info if any
9.1.5	Should include inserts for flat specimens up to 8 mm thickness or higher and for round specimen from 3 to 6 mm diameter.		
9.2	Suitable grips for 1 kN for ambient testing of thin foil specimens of 0-1 mm thickness. A suitable specimen alignment setup to be provided.		
9.3	Suitable grips for testing of wires up to 2 mm diameter.		

9.4 Self-sustained corrosion cell

Sr. No	Particular	Compliance (Yes/No)	Additional Info if any
9.4.1	For corrosion tests on various materials with the possibility of implementation of a thermostat, and is suitable for salt, alkaline and acidic solutions.		
9.4.2	Volume max. 28 liters or more		
9.4.3	Material Plexiglas		

9.4.4	Temperature range -40° to +95°C		
9.4.5	Dimensions W 400 mm x D 200 mm x H 400 mm or more		

9.5 Set of Extension Push-Pull Rods with integrated electrical isolation for corrosion cells.

Sr. No	Particular	Compliance (Yes/No)	Additional Info if any
9.5.1	Load: ±10 kN		
9.5.2	Material: High strength and corrosive-resistant/suitable isolation material PEEK		
9.5.3	Temperature range -80° to +260°C		
9.5.4	Dimensions: Diameter 80 mm x Height 700 mm or more		

10.High Temperature Furnace System

10.1Furnace

Sr. No	Particular	Compliance (Yes/No)	Additional Info if any
10.1.1	The offer shall include 2-zone split construction slidable Box furnace with a maximum temperature of 1300 °C or more.		
10.1.2	Should have various removable insulation blocks to suit specific specimen geometry.		
10.1.3	The furnace should be enclosed in a polished stainless-steel case with ventilated terminal covers.		
10.1.4	The furnace should be heated by two parallel banks of silicon carbide elements.		
10.1.5	Average rate of heating: 45 to 50 °C per minute or better.		
10.1.6	Control thermocouples: Type R		
10.1.7	Temperature stability and Uniformity: $\pm 2^{\circ}\text{C}$		
10.1.8	Minimum heating zone dimension: W 50 mm x D 50 mm x H 55 mm		
10.1.9	For safety reasons the power to the furnace should be disconnected when furnace halves are separated.		
10.1.10	The offer shall include a furnace mounting bracket and slidable thermocouple arrangement.		
10.1.11	The power supply should be 230V, 50 Hz, 2 kW		

10.2 Temperature control

Sr. No	Particular	Compliance (Yes/No)	Additional Info if any
10.2.1	PID controllers shall be Eurotherm/ Yokogawa make.		
10.2.2	Furnace temperature shall be controlled by two "R" type thermocouples. Each thermocouple shall control each zone of the furnace independently. Thermocouple tolerance shall be Class-1.		

10.2.3	Controllers shall be interfaced with the computer/Machine Controller such that all temperature readings are displayed on the computer too. This includes live temperature readings of three (03) thermocouples, etc., for each furnace. Facility of logging and saving of the temperature data and plotting of graph (Temperature vs time).		

10.3 High-Temperature 10.3 High-Temperature Pull Rods and Grips

Sr. No	Particular	Compliance (Yes/No)	Additional Info if any
10.3.1	A set of high-temperature pull rods		
10.3.2	Spherical seated adapters for pull rods		
10.3.3	High-temperature Wedge Grips made of MAR 247 material for tensile tests on flat specimens.		
	<ul style="list-style-type: none"> Max. temperature 1300°C (TS = 70 MPa). 		
	<ul style="list-style-type: none"> Load maximum at 1000°C is 15 kN. 		
	<ul style="list-style-type: none"> Suitable for Sample thickness 0 – 8 mm or more 		
	<ul style="list-style-type: none"> Suitable for Sample width max. 30 mm or more 		
	<ul style="list-style-type: none"> Centring pin diameter 2.3 mm or more 		
	<ul style="list-style-type: none"> Dimensions: Diameter 50 mm x H 65 mm or higher 		
	<ul style="list-style-type: none"> Set of Jaws for Flat Specimens 0 – 1 mm 		

11.Non-Contact High Accuracy Video Extensometer

Sr. No	Particular	Compliance (Yes/No)	Additional Info if any
11.1	The Video Extensometer should provide contactless and wear-free strain measurements.		

11.2	The digital strain data should get transferred in real-time to the testing machine.		
11.3	The Perspective correction should allow the measurement under angle - the camera does not have to be perpendicular to the measurement plane.		
11.4	The coordinate system offset, based on specimen thickness or diameter – should be automatically calculated and corrected.		

11.5	Should be capable of measuring the strain/displacements in a wide test temperature range up to 1300 °C.		
11.6	Should have selectable single or multiple gauge lengths.		
11.7	Should have simplified calibration process - the calibration and lens distortion correction should be done within one process.		
11.8	Should have compensation factor - possibility of correcting the calibration based on known strain or displacement - extensometer calibration.		
11.9	Should have ROI/AOI - High FPS at a smaller width.		
11.10	API functions for remoter control through RS232 and TCP/IP.		
11.11	Should have Unlimited virtual measurement tools - limited only by PC performance		
11.12	Should have Classification ISO 9513/ASTM E83 Class 0.5 / B-1		
11.13	Should have a Resolution of 0.2 µm or better		
11.14	Should have Dynamic measurement max. 5 – 7 Hz		
11.15	Should have a Measuring rate >70 Hz		
11.16	Should have at least one number of camera (2D representation)		
11.17	The Camera resolution should be 5 MPx or better.		
11.18	Quartz window W 35 x H 95 mm		

11.19	Should include suitable lens to have Field of view W 41 mm x H 47 mm for Class 0.5 accuracy or better.		
11.20	LED light green.		

12. Installation and Commissioning:

Sr. No	Particular	Compliance (Yes/No)	Additional Info if any
12	The vendor should take full responsibility for the supply, installation, and commissioning of the testing system in IIT Bombay and the performance of the system demonstrated to the satisfaction of the users. The necessary fittings and fixtures required for the installation will be in the scope of the vendor.		

13. Maintenance and Service Support of the system during and after the warranty period:

Sr. No	Particular	Compliance (Yes/No)	Additional Info if any
13.1	The vendor should have a competent and reliable service network in India for quick and necessary repair and maintenance of the equipment.		
13.2	Necessary consumables like connecting cables, power pack oil, hoses, etc. will be in the vendor's scope.		
13.3	The vendor should provide the list of users of similar equipment (viz. IITs, NITs, national labs, etc.) along with their contact details.		
13.4	Details of the nature of service support the vendor can provide should be given along with the proposal.		
13.5	The vendor should commit providing maintenance service and supply necessary spares for the equipment for at least 10 years after successful installation and commissioning. Up-gradation of software free for 10 years that will be compatible with any higher version of the Windows operating system		

14. Essential criteria:

Sr. No	Particular	Compliance (Yes/No)	Additional Info if any
14.1	The company should have the experience of supplied and setting up at least two such horizontal testing instrument in India. User names and references should be provided along with the bid. Provide proof of supply (purchase order/commissioning certificates). The IITB may contact them if required.		
14.2	A set of operation and maintenance manuals along with all necessary drawings should be supplied with the testing system.		
14.3	The vendor should enclose all the relevant technical documents and catalogues for all the components included in the proposal.		

15. Other terms and conditions

Sr. No	Particular	Compliance (Yes/No)	Additional Info if any
15.1	Maximum education discount, if any, should be offered. Details of all taxes and duties must be specified clearly. Prices should include the installation and training cost.		
15.2	Training to laboratory personnel after installation and commissioning at IIT Bombay (at least 7-man days of training)		
15.3	Validity of quotation should be at least for 180 days.		
15.4	The warranty has to be valid for minimum three years after installation.		
15.5	The machine should be provided within 28 weeks after the release of purchase order.		

