

TECHNICAL SPECIFICATION OF X-RAY DIFFRACTOMETER

Offers are invited from the reputed vendor for the procurement of floor mounted X-Ray Diffractometer System, which will be used for advance material research on powders, thin films and bulk solids of polycrystalline, nanocrystalline and amorphous nature. The system must combine high resolution horizontal sample mount X-ray diffractometer with theta-theta (θ - θ) goniometer having the capability of high resolution scanning mode with fully automatic and knowledge based control system. The XRD system should be equipped with automatic component recognition system with conflict detection in real time mode for all components in the beam path including X-ray tube, optics in both primary and secondary side along with the detector to be used. The XRD system must have the capability to configure in different modes like

High resolution powder X-Ray Diffraction (HR XRD)

Grazing Incidence X-Ray Diffraction (GIXRD)

Small angle X-ray scattering (SAXS) – **Quote as option**

Residual Stress and Texture (Pole figure) – **Quote as option**

DETAILED TECHNICAL SPECIFICATION:

I. X-RAY GENERATOR

Power	Maximum continuous output power of 3 KW or higher
Input voltage	240 V
Rated Voltage	20 – 50 KV or better (in steps of 1 KV)
Rated Current	5 – 60 mA or better (in steps of 1 mA)
Stability	$\pm 0.01\%$ per 10% main variations
Cooling	The system should have requisite cooling system - external chiller / heat exchanger etc. for smooth and stable running. The external chiller should be quoted from International reputed brand.
Control	Fully controlled through Windows based PC software. User could able to set the voltage and current using the software loaded on the PC.
Safety Device	Abnormal cooling water, flow rate, water Pressure, Temperature detection, abnormal XG load (over load, line current, abnormal low and high voltage, emergency stop switch, leak breaker), shutter malfunction detection, etc.

II. X-RAY TUBE

Insulation	Ceramic
Anode material	Cu anode; The system should also be able to work with other X-ray sources like Mo, Co, Fe, or Cr. Also quote X-ray tube with Mo anode (Optional) .
Maximum power	2 kW or higher

Focus	Fine focus, long line fine focus with Ni K _β Filter. Facility to switch between line and point focus applications without disconnecting cables and utility lines or unscrewing the X-ray tube.
Tube Shield	Electro-magnetic shutter interlocked with radiation enclosure.

III. GONIOMETER

Geometry	Vertical (keeps sample horizontal)
Operation mode	Theta - Theta
Scanning mode	θ_D/θ_S independent or coupled
2 theta range	-10 to 160 deg or better (with capability of transmission mode)
Minimum Scan Speed	0.001 deg/sec or better
Slew speed	9 deg / sec or higher
Min step size	0.0001° or better.
Diameter	Minimum diameter of 260 mm or better without major alignment procedure
Angular accuracy	0.005 deg or better
Angular reproducibility	0.0001 deg or better

IV. OPTICS

Slit type	- Automatic Computer Controlled & Programmable Variable slit - Alignment-free and tool-free change of optics
Incident slit and Receiving slit	Motorized slit and parabolic multilayer mirror for changing from Bragg & Brentano focusing optics to parallel multilayer mirror; 0.01 mm Step or better
Slit specification	Motorized slit and Soller collimator along with Anti-scatter slit assembly to reduce air scattering particularly for low angle measurements; for incident beam and for detector
Fluorescence suppression	Suitable hardware and software for suppressing secondary fluorescence must be included.
Height limiting slit	Necessary height limiting slits are to be included
Optical system alignment	Complete automatic alignment without manual intervention is needed. Automatic Alignment should be done by the software for the alignment of source height, source angle, mirror optic, crystal optic, slit height, sample surface and detector angle.

V. DETECTOR

Type	<ul style="list-style-type: none"> • Solid state high speed detector equipped with diffracted beam monochromator; must be maintenance-free and must work without using any cooling agent or gas. • The quotation should contain all authentic documents and technical details from the original detector manufacturer for the quoted detector. • It should offer good angular resolution and perfect profile shapes with no defective channels/pixels and operable for all kinds of radiations ex. Cu, Co, Cr, Fe & Mn.
Operation mode	0D, 1D & 2D mode must be possible. The same detector must also work in normal mode or in fluorescence reduction mode.
Count rate	10 ⁶ cps or better with linearity at this count rate to be minimum 97% or better for Cu.
Spatial resolution (pitch)	75 μm or better. The detector resolution should preferably not change with change in sample to detector distance.
Capture angle	>2.5° 2Theta angular coverage at 500 mm measurement circle diameter on both X & Y direction. All channels/pixels should remain active for minimum 5 year from start of use. In case if any of pixel/channel found dead within this period supplier has to replace with a new detector FREE of cost.
Background noise	< 1cps across the whole detector
Energy resolution	< 680 eV for Cu radiation at 25°C
Fluorescence suppression	Suitable hardware and software for suppressing secondary fluorescence to be offered.
Low Angle Data	Capable to collect high quality data starting at angles as low as 0.15° 2Theta.

VI. SAMPLE STAGES

Sample stage type	<ul style="list-style-type: none"> • Computer controlled rotating sample stage with ability to control & vary the rotating speed for orientation studies with suitable motors. This stage should facilitate both reflection & transmission measurements with sample horizontal. • Capable to accommodate samples of different thickness with minimum 20 numbers of sample holder (for spinning and non-spinning)
Sample stage for stress, texture and thin film study (Option)	Motorized Chi and Phi rotations, and Z translations suitable for thin film, texture, residual stress and other measurements.

For small samples	Silicon zero background sample holders to hold small sample size (150 mg) – flat and cavity type or equivalent, 5 No's each should be supplied which can be used with rotating sample stage.
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VII. SAFETY AND RADIATION ENCLOSURE

- The XRD system must be fully radiation protected as per the Indian and International radiation safety norms.
- The offered XRD system must comply with the requirements of the Machinery Directive 2006/42/EC for European Manufacturer or equivalent norm for non-European Manufacturer.
- The system must display an up-to-date CE marking, accompanied by a correct EC Declaration of Conformity as well as all required documentation.
- Open & Close Door System (with a Pb-contained Acrylic Resin Windows or equivalent)
- Lead equivalent: 0.5 mm Pb equivalent or better.
- Fail Safe Function: With a CPU Controlled function.
- Warning Light: Installed independently on the top of the Radiation Enclosure.

VIII. SOFTWARE

- i. General - The software should be capable of simultaneous diffractometer control, data collection and analysis, peak search, search match, profile fitting and elaborate pattern treatment such as data smoothening, background subtraction, $k\alpha_2$ stripping, etc with minimum **five multi user protected licenses** for independent systems. Software should have facility for remote operation and diagnostics of the instrument.
- ii. Quantitative phase analysis with various whole pattern methods for amorphous as well as crystalline phases by employing Rietveld, Internal Standard, External Standard, phases with known or unknown structure.
- iii. Software should be enabled with latest Rietveld algorithm for standard-less quantitative analysis.
- iv. Manufacturer must offer their licensed software with certificates along with media and exhaustive operating manual(s). Licenses for all the databases and computational software should be for minimum of five years with updates. Periodic updates of all the software should be provided free of cost for a period of minimum five years.
- v. Latest ICDD Database with Minimum five User - 5 years License must be offered.
- vi. Suitable Software for Texture and Stress measurements and analysis (**Option**)

IX. Warranty/AMC:

Minimum **five year** on-site Warranty / Guarantee commencing from the date of complete and satisfactory installation of the equipment against the defect of any manufacturing, workmanship and poor quality of the components. The bidder also must agree and issue a certificate stating that technical query will be responded within 2 working days and the on-site support will be provided within 07 working days from the date of reporting of the technical failure for down time free operation of the instrument.

AMC (OPTIONAL):

AMC (annualized) for 60 months after completion of standard warranty period.

Other requirements:

- (i) Manuals (both electronic and hard copy)
- (ii) Installation: The satisfactory free installation to the full specifications of the machine with all accessories at TIET within one month of receipt of goods at TIET. Any additional equipment/accessory for the installation of the system should be quoted invariably. Institute will provide only space and electrical connection.
- (iii) Training: Free **ONE WEEK** training to operators and students/staffs to the satisfaction.
- (iv) Consumables and other items required to handle the system while operating all measurement options, must be quoted for enough quantity for uninterrupted operation of the machine for at least FIVE year.
- (v) Quote separately for all optional items/accessories and consumables which are not explicitly specified above however required for smooth functioning of the machine.
- (vi) A list of institutes with complete contact details in India where the same equipment in this document has been sold (2016 onwards) or is under operation should be provided. Prospective vendor should clearly mention the type of measurement options (along with the main system) supplied to these institutes.
- (vii) NIST standard samples-for-calibrations and operation should be provided. Standard samples data should be measured before shipping from manufacturing unit and the same/comparable data should be reproduced after installation.

OTHER ESSENTIAL ITEMS

Computer & Printer	Suitable branded computer with latest WINDOWS operating system with pre-loaded software(s) and color laser jet printer must be offered. Physical disk(s) or media of all loaded software including Windows OS must be supplied.
Water Chiller	Suitable closed loop water chiller from International reputed brand for the system should be offered with capability to work in ambient temperature. The water chiller along with the complete XRD system should be on UPS power supply.
UPS	15 KVA or better UPS with 30 min back up must be offered.
Spares	Commitments to supply spares for at least 10 years to be ensured. Separate Spare kits for the diffractometer system should be quoted.

NECESSARY NOTE:

1. Just complying above specifications will not warrant qualifying for the price bid stage. Shortlisting of valid technical quotes will be done before the price bid opening. Shortlisting of the quotations will be done on the basis of technical quality/level of quoted components of system, experimental flexibility, Installations in India, indenter's hands-on experience on various systems, user feedbacks, etc.
2. Shortlisted vendors will be provided an opportunity to present the technical aspect of their product before a competent technical evaluation panel at TIET. The panel may ask the selected vendors to arrange demonstration/measurement on their machine at user facility.

TERMS AND CONDITIONS:

1. The printed manufacturer documents supporting above mentioned technical specifications/points must be provided. Each point given in the specification sheet must be clearly visible and highlighted in COLOR.
2. Omission of any technical point given in specification sheet OR failing to provide clear documentary support of any of technical points may lead to the rejection of the quotation without any clarification from the vendor.
3. Validity of quote should be at least **120 days** from the date of submission.
4. **Price** must be quoted component wise strictly. Failing will disqualify the quote.
5. Supply list of part numbers with the quote.
6. Vendors should submit **LIST** of previously (2016 - onwards) installed XRD systems with the quote bearing complete address and contact details of the user (phone no and email ID).
7. In case the vendor is not OEM, original authorization certificate with validity from the OEM is required for consideration of the quote.
8. A certificate from OEM explicitly mentioning that the spare parts/accessories will be made available for 10 years from the date of discontinuation of the model by the manufacturer.
9. The supplier should provide calibration/traceability certificate of the equipment as per National institute of Standards & Technology (NIST) / National Physical Laboratory (NPL) UK/ United Kingdom Accreditation System (UKAS), wherever applicable.
10. Break up of price for **optional items** should be shown separately in the price bid.
11. The vendor has to submit pre-installation site requirements/guidelines for the XRD system along with the technical bid.

Compliance statement

Sr. No.	Required Indent Specifications	Please mention your remarks, details or mention the value of specifications
1	Is the bidder original equipment manufacturer (OEM)/authorized dealer?	
2	If authorized dealer, recent dated certificate to this effect from OEM, attached or not ?	
3	Undertaking from OEM regarding technical support & extended warranty.	
4	Offer validity of 120 days or not?	
5	Undertaking from bidder regarding acceptance of terms & conditions	
6	List of reputed users for the past three years (2016 - onwards) specific to the instrument model quoted	
7	Whether special educational discount for TIET given?	
8	Whether one week of training of operator and research students without any charge offered?	
	TECHNICAL SPECIFICATIONS	
9	I. X-RAY GENERATOR (YES/NO and mention specific details)	
	Power Maximum continuous output power of 3 KW or higher	
	Input voltage 240 V	
	Rated Voltage 20 – 50 KV or better (in steps of 1 KV)	
	Rated Current 5 – 60 mA or better (in steps of 1 mA)	
	Stability ±0.01% per 10% main variations	
	Cooling Whether quoted for external chiller? (Mention make, model and other specifications)	
	Safety Device Is the quoted system equipped with detection system for Abnormal cooling water, flow rate, water Pressure, Temperature detection, abnormal XG load (over load, line current, abnormal low and high voltage, emergency stop switch, leak breaker), shutter malfunction detection, etc. ?	
10	II. X-RAY TUBE (YES/NO and mention specific details)	
	Insulation Ceramic	
	Anode material Cu anode; Will the system work with other X-ray sources like Mo, Co, Fe, or Cr ? Whether X-ray tube with Mo anode quoted ?	

	Maximum power	2 kW or higher	
	Focus	Fine focus, long line fine focus with Ni K_{β} Filter. Facility to switch between line and point focus applications without disconnecting cables and utility lines or unscrewing the X-ray tube.	
	Tube Shield	Electro-magnetic shutter interlocked with radiation enclosure.	
11.	III. GONIOMETER (YES/NO and mention specific details)		
	Geometry	Vertical (keeps sample horizontal)	
	Operation mode	Theta - Theta	
	Scanning mode	θ_D/θ_S independent or coupled	
	2 theta range	-10 to 160 deg or better (with capability of transmission mode)	
	Minimum Scan Speed	0.001 deg/sec or better	
	Slew speed	9 deg / sec or higher	
	Min step size	0.0001° or better	
	Diameter	Minimum diameter of 260 mm or better	
	Angular accuracy	0.005 deg or better	
	Angular reproducibility	0.0001 deg or better	
12.	IV. OPTICS (YES/NO and mention specific details)		
	Slit type	- Automatic Computer Controlled & Programmable Variable slit - Alignment-free and tool-free change of optics	
	Incident slit and Receiving slit	Motorized slit and parabolic multilayer mirror for changing from Bragg & Brentano focusing optics to parallel multilayer mirror; 0.01 mm Step or better	
	Slit specification	Motorized slit and Soller collimator along with Anti-scatter slit assembly to reduce air scattering particularly for low angle measurements; for incident beam and for detector	
	Fluorescence suppression	Suitable hardware and software for suppressing secondary fluorescence.	
	Height limiting slit	Necessary height limiting slits are quoted	
	Optical system alignment	Whether alignment is fully automatic (without manual intervention) ?	
13.	V. DETECTOR (YES/NO and mention specific details)		

Type	<ul style="list-style-type: none"> • Solid state high speed detector equipped with diffracted beam monochromator; must be maintenance free and must work without using any cooling agent or gas. • Whether all authentic documents and technical details from the original detector manufacturer for the quoted detector included ? 	
Operation mode	0D, 1D & 2D mode Whether same detector will work in normal mode and in fluorescence reduction mode ?	
Count rate	10^6 cps or better with linearity at this count rate to be minimum 97% or better for Cu.	
Spatial resolution (pitch)	75 μ m or better.	
Capture angle	>2.5° 2Theta angular coverage at 500 mm measurement circle diameter on both X & Y direction. Whether a certificate attached from OEM explicitly mentioning that a new detector will be provided free of cost if any channel(s)/pixel(s) become inactive within 5 year from the date of installation ?	
Background noise	< 1cps across the whole detector	
Energy resolution	< 680 eV for Cu radiation at 25°C	
Fluorescence suppression	Whether suitable hardware and software for suppressing secondary fluorescence offered ?	
Low Angle Data	Capable to collect high quality data starting at angles as low as 0.15° 2Theta.	
14.	VI. SAMPLE STAGES (YES/NO and mention specific details)	
Sample stage type	<ul style="list-style-type: none"> • Computer controlled rotating sample stage with ability to control & vary the rotating speed for orientation studies with suitable motors. This stage should facilitate both reflection & transmission measurements with sample horizontal. • Capable to accommodate samples of different thickness with minimum 20 numbers of sample holder (for spinning and non-spinning) 	

	Sample stage for stress, texture and thin film study (Optional)	Motorized Chi and Phi rotations, and Z translations suitable for thin film, texture, residual stress and other measurements.	
	For small samples	Silicon zero background sample holders to hold small sample size (150 mg) – flat and cavity type or equivalent, 5 No's each should be supplied which can be used with rotating sample stage.	
15.	VII. SAFETY AND RADIATION ENCLOSURE (YES/NO and mention specific details)		
	i.	Whether documents mentioning that the XRD system is fully radiation protected as per the international radiation safety norms ?	
	ii.	Whether the offered XRD system comply with the requirements of the Machinery Directive 2006/42/EC for European Manufacturer or equivalent norm for non-European Manufacturer.	
	iii.	Lead equivalent of enclosure: 0.5 mm Pb equivalent or better.	
	iv.	Fail Safe Function: With a CPU Controlled function.	
16.	VIII. SOFTWARE (YES/NO and mention specific details)		
	i.	Whether The software for simultaneous diffractometer control, data collection and analysis, peak search, search match, profile fitting and elaborate pattern treatment such as data smoothing, background subtraction, $k\alpha_2$ stripping, etc provided ? Whether minimum five multi user protected licenses for independent systems offered? Whether the Software has facility for remote operation and diagnostics of the instrument ?	
	ii.	Quantitative phase analysis with various whole pattern methods for amorphous as well as crystalline phases by employing Rietveld, Internal Standard , External Standard , phases with known or unknown structure.	
	iii.	Software should be enabled with latest Rietveld algorithm for standard-less quantitative analysis.	

	iv.	Whether licenced software with certificates along with media and exhaustive operating manual(s) included ? Whether licenses for all the databases and computational software are valid for five years ?	
	v.	Whether latest ICDD Database with minimum five User - 5 years license offered ?	
	vi.	Whether suitable Software for Texture and Stress measurements and analysis (Option) included ?	
17.	IX. Warranty/AMC:		
	Whether minimum five year on-site Warranty/ Guarantee commencing from the date of complete and satisfactory installation of the equipment offered ? Whether a certificate stating that technical query will be responded within 2 working days and the on-site support will be provided within 07 working days from the date of reporting of the technical failure for down time free operation of the instrument is included ? AMC (OPTIONAL): Whether AMC (annualized) for 60 months after completion of standard warranty period offered ?		
18.	Other Requirement (YES/NO and mention specific details)		
	i.	Manuals (both electronic and hard copy)	
	ii.	Whether free Installation within one month of receipt of goods at TIET included in the offer?	
	iii.	Whether Consumables, tool kit and other items required to handle the system while operating all measurement options are quoted for enough quantity for uninterrupted operation of the machine for at least FIVE year ?	
	iv.	Whether all optional items/accessories and consumables which are not explicitly specified in this document however required for smooth functioning of the machine are offered?	
19.	OTHER ESSENTIAL ITEMS		
	Computer & Printer	Whether suitable branded computer with latest WINDOWS operating system with pre-loaded software(s) and color laser jet printer offered ? Whether physical disk(s) or media of all loaded software including Windows OS included in the offer ?	

Water Chiller	Is suitable closed loop water chiller from international reputed brand for the system offered ?	
UPS	Whether the offered UPS can take load of XRD system and quoted chiller ? (Give details / specifications)	
Spares	Whether a certificate of Commitment to supply spares for at least 10 years is included?	