Specification of Thin Film Thickness Measuring Equipment

A. Application: Major application is for solar cell thin film thickness measurement for films such as CIGS, CdS, ITO, ZnO etc. deposited on substrates such as glass, metal foils, plastics. The equipment will also be used for measurement of thickness of thin films of other materials.

B. Main Features :

1. Spectrometer, A / D converter, reflection probe and suitable software for measurement of thin films.
2. Light source - Suitable Tungsten halogen lamp
3. Angle of incidence - 90˚ (normal incidence)
4. Effective wavelength covering a range of 400 nm to 1700 nm
5. Type of detectors – Silicon array and InGaAs array (or any other suitable) covering 400 nm – 1700 nm wavelength range. Type of detector should be mentioned in the offer.
6. Thickness range of measurement - Equipment should be capable of measuring thickness of films in the thickness range of 20 nm – 100 μm.
7. Number of layers - The equipment should be capable of measuring single film and multiple films (minimum 5 layers) deposited one over the other.
8. The equipment should be capable of measuring thicknesses of typical layer materials used in solar cell applications as mentioned below:
   a) Copper-Indium-Gallium-Selenide(CIGS)
   b) Cadmium Sulphide (CdS)
   c) Zinc Oxide (ZnO)
   d) Indium - Tin – Oxide (ITO)
   Various other films that can be studied also should be mentioned.
9. Supporting technical data: Graphical representation (Reflectance (%) versus wavelength (nm) of incident light) of actually measured samples using your equipment for films such as i) CIGS, ii) CdS, or combination should be enclosed along with the thickness data. If any such data for other materials is available it should be provided.
10. Optical fiber cable and probe - Suitable optical fiber cable and probe for transmitting light from source to the sample and to collect and re-transmit the reflected light from the sample to the spectrometer should be provided.
11. Sample stand – Sample stand with probe holder suitable for measuring samples at least up to 100 mm diameter should be provided. It should be capable of accommodating substrates of thickness at least up to 10 mm.
12. Spot Size – A spot size within the range of 1 mm to 3 mm should be provided.

13. Absolute accuracy - < 1 % (measured with SiO_2 on Si)
14. Reference material and thickness standard **(**SiO_2 on Si wafer) for demonstration should be supplied along with the equipment. Details to be provided.
15. Thickness measurement precision - 0.1 nm
16. Measurement of optical properties such as refractive index (n) and extinction coefficient (k) should be possible.

C. Software :

1. Suitable software for measurement of thickness of single layer as well as of multiple layers (min. 5 different layers one above the other) to be provided.
2. The software should be compatible with Microsoft Office products and it should operate under **Windows XP Environment**.
3. **PC along with LCD monitor (17") and printer** to be provided with details. All catalogues related to Software / Hardware to be provided. It is preferable to supply PC available in India with software loaded and integrated with the system.
   PC of make Dell or HP or COMPACQ Desktop, with minimum configuration Intel dual core CPU, 2.8 GHz, 2 GB DDR3, 320 GB HDD, DVD RW, 17" or 18.5" TFT Colour Monitor, Key Board, Optical Scroll Mouse, and HP PSC F 4488 or equivalent or better Printer to be provided.
4. Interface - USB / RS232
5. The computer and accessories should be Guaranteed for a period of **2 years from the date of installation at R&D**

D. Power Input :

1. The complete system comprising of spectrometer, computer, printer, UPS etc. should be designed for use with 220 - 240 V A.C. (1 phase) with a mains frequency of 50 ± 1% Hz.
2. **Suitable UPS (reputed make like APC/Leibert/SOCOMEC)** with backup power of up to 30 minutes to be quoted with details separately. The UPS should be Guaranteed for a period of **2 years from the date of installation at R&D.**

E. Other aspects:

1. The vendor **should have supplied minimum two such equipments and the addresses of the customers with telephone numbers should be furnished.**
2. Should have agents in India to provide after sales service and maintenance.

3. The 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 suppliers works, transportation cost of equipment / component besides repair / replacement charges, if any, should be borne by the supplier.
4. **Catalogue related to each and every item should be enclosed.**
5. Dimensions of equipment, weight and space requirements to be given.
6. **Pre-installation requirements should be furnished.**
7. Installation & commissioning of the equipment to be carried out by supplier at site at Corporate R&D, BHEL, Hyderabad, India. Training to be provided at Corp. R&D, BHEL, Hyderabad, India.
8. Commissioning charges, if any, to be indicated separately.
9. Compliance statement of specification to be submitted along with the offer. Without compliance statement, the offer is liable to be rejected. All tender specifications to be compared with equipment offered line by line and documentary evidence must be enclosed by the supplier along with quotation.
10. Two copies of operating manual to be provided along with the equipment.

P.T.O.

COMPLIANCE STATEMENT

Item: Thin Film Thickness Measuring Equipment

Sl. No.	BHEL Specification / Requirement	Supplier's Offer	Meets BHEL Specification or not	Remark
B1	Spectrometer, A / D converter, reflection probe and suitable software for measurement of thin films.			
B2	Light source - Suitable Tungsten halogen lamp			
B3	Angle of incidence - 90˚ (normal incidence)			
B4	Effective wavelength covering a range of 400 nm to 1700 nm			
B5	Type of detectors – Silicon array and InGaAs array (or any other suitable) covering 400 nm – 1700 nm wavelength range. Type of detector should be mentioned in the offer.			
B6	Thickness range of measurement - 20 nm – 100 µm.			
B7	Number of layers - The equipment should be capable of measuring single film and multiple films (minimum 5 layers) deposited one over the other.			

COMPLIANCE STATEMENT (Contd. 2)

Item: Thin Film Thickness Measuring Equipment

Sl. No.	BHEL Specification / Requirement	Supplier's Offer	Meets BHEL Specification or not	Remark
B8	Measuring thicknesses of typical layer materials as mentioned below: a) Copper-Indium-Gallium-Selenide (CIGS) b) Cadmium Sulphide (CdS) c) Zinc Oxide (ZnO) d) Indium - Tin – Oxide (ITO)			
B9	Supporting technical data: Graphical representation (Reflectance (%) versus wavelength (nm) of incident light) of actually measured samples using your equipment for films such as i) CIGS, ii) CdS, or combination should be enclosed along with the thickness data.			
B10	Optical fiber cable and probe			
B11	Sample stand – Sample stand with probe holder suitable for measuring samples at least up to 100 mm diameter should be provided. It should be capable of accommodating substrates of thickness at least up to 10 mm.			

COMPLIANCE STATEMENT (Contd. 3)

Item: Thin Film Thickness Measuring Equipment

Sl. No.	BHEL Specification / Requirement	Supplier's Offer	Meets BHEL Specification or not	Remark
B12	Spot Size – A spot size within the range of 1 mm to 3 mm should be provided.			
B13	Absolute accuracy - < 1 % (measured with SiO_2 on Si)			
B14	Reference material and thickness standard **(**SiO_2 on Si wafer) for demonstration should be supplied along with the equipment. Details to be provided.			
B15	Thickness measurement precision - 0.1 nm			
B16	Measurement of optical properties such as refractive index (n) and extinction coefficient (k) should be possible.			
C1	Suitable software for measurement of thickness of single layer as well as of multiple layers (min. 5 different layers one above the other) to be provided.			
C2	The software should be compatible with Microsoft Office products and it should operate under **Windows XP Environment**.			

COMPLIANCE STATEMENT (Contd. 4)

Item: Thin Film Thickness Measuring Equipment

Sl. No.	BHEL Specification / Requirement	Supplier's Offer	Meets BHEL Specification or not	Remark
C3	**PC along with LCD monitor (17") and printer** to be provided with details. All catalogues related to Software / Hardware to be provided. It is preferable to supply PC available in India with software loaded and integrated with the system. PC of make Dell or HP or COMPACQ Desktop, with minimum configuration Intel dual core CPU, 2.8 GHz, 2 GB DDR3, 320 GB HDD, DVD RW, 17" or 18.5" TFT Colour Monitor, Key Board, Optical Scroll Mouse, and HP PSC F 4488 or equivalent or better printer to be provided.			
C4	Interface - USB / RS232			
C5	The computer and accessories should be Guaranteed for a period of **2 years from the date of installation at R&D.**			
D1	The complete system comprising of spectrometer, computer, printer, UPS etc. should be designed for use with 220 - 240 V A.C.(1 phase) with a mains frequency of 50 ± 1% Hz.			

COMPLIANCE STATEMENT (Contd. 5)

Item: Thin Film Thickness Measuring Equipment

Sl. No.	BHEL Specification / Requirement	Supplier's Offer	Meets BHEL Specification or not	Remark
D2	**Suitable UPS (reputed make like APC/Leibert/SOCOMEC)** with backup power of up to 30 minutes to be quoted with details separately. The UPS should be Guaranteed for a period of **2 years from the date of installation at R&D.**			
E1	The vendor **should have supplied minimum two such equipments and the addresses of the customers with telephone numbers should be furnished.**			
E2	Should have agents in India to provide after sales service and maintenance.			
E3	The 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 suppliers works, transportation cost of equipment / component besides repair / replacement charges, if any, should be borne by the supplier.			
E4	**Catalogue related to each and every item should be enclosed.**			
E5	Dimensions of equipment, weight and space requirements to be given.			

COMPLIANCE STATEMENT (Contd. 6)

Item: Thin Film Thickness Measuring Equipment

Sl. No.	BHEL Specification / Requirement	Supplier's Offer	Meets BHEL Specification or not	Remark
E6	**Pre-installation requirements should be furnished.**			
E7	Installation & commissioning of the equipment to be carried out by supplier at site at Corporate R&D, BHEL, Hyderabad, India. Training to be provided at Corp. R&D, BHEL, Hyderabad.			
E8	Commissioning charges, if any, to be indicated separately.			
E9	Compliance statement of specification to be submitted along with the offer. Without compliance statement, the offer is liable to be rejected. All tender specifications to be compared with equipment offered line by line and documentary evidence must be enclosed by the supplier along with quotation.			
E10	Two copies of operating manual to be provided along with the equipment.			