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› Ellipsometry for solar cells
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› Absorption spectroscopy
› Photoluminescence measurements
› CdTe surface chemistry and roughness
› CIGS grain morphology
› PV-grade silicon contaminant identification
› Composition and dopant depth profiling

YOUR MATERIALS ANALYSIS EXPERTS

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TOF-SIMS

AFM

RBS

FTIR

ERD

XRD

XPS

RAMAN

ELLIPSOMETRY

SEM

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THIN FILM RESEARCH LABORATORY
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MATERIALS CHARACTERIZATION AND MICROANALYSIS

	Analytical techniques	Typical applications	Resolution / sensitivity	Depth resolution	Lateral resolution	Other characteristics
SPECTROSCOPY/SPECTROMETRY	**Time-of-flight SIMS** *IONTOF TOF-SIMS IV*	Surface microanalysis of organic and inorganic materials, composition mapping, depth profiling	0.0001 amu $10^8 – 10^{11}$ at/cm^2	1 – 3 monolayers (static mode)	≥ 150 nm	Mapping T = -196 – 600˚C
	XPS/UPS *VG Scientific ESCALAB 3 MKII* *Kratos AXIS ULTRA*	Surface analysis of organic and inorganic materials, depth profiling, valence electron energy	0.1 – 1 at% 0.7 eV (VG) 0.26 eV (Kratos)	1 – 10 nm	250 µm (VG) 15 µm nominal 1 µm (imaging)	Mapping T = -196 – 600˚C Preparation and deposition chamber
	SAM/Auger *Omicron NanoTechnology*	Surface and defect analysis, depth profiling	0.1 – 1 at%	2 – 20 nm profiling 3 nm surface	~ 10 nm	EBSD-UHV, preparation chamber (deposition, heating >1000°C), imaging during heating, ion sputtering
	FTIR *Digilab FTS7000; BioRad FTS6000; BioRad FTS3000*	Identification of organics and inorganics, local measurement of stress, structure determination	0.5 cm^{-1} 1 – 5 wt%	0.1 – 5 µm	imaging : ~ 5 µm	Mapping, step-scan, ATR, photoacoustic cell, depth profiling, MP-IRRAS Wave number range: 400 - 4000 cm^{-1}
	RAMAN Microspectroscopy *Renishaw RM3000; Renishaw InVia; ISA U1000; PI-Acton TriVista*	Identification of organics and inorganics, local measurement of stress, structure determination	2 – 5 cm^{-1} ≥ 1 wt%	2 µm	1 µm	λ : 488, 514, 633, 782 nm Mapping and depth profiling, confocal mode, line focus
	Absorption spectroscopy *BOMEM DA-3 ; ORIEL MS260i*	Band structure, impurities, oscillator forces, film thickness, optical properties determination	4 cm^{-1}	-	1 mm	T = 4 – 300 K Spectral range: 320 – 3000 nm
	Photoluminescence (PL); excitation PL and time-resolved PL *BOMEM DA3; ISA U1000; ORIEL MS260i; PI-Acton TriVista*	Band structure, impurities, oscillator forces, relaxation dynamics of photogenerated carriers	0.005 nm	-	1 mm	T = 4 K – 300 K Wave length range (CW PL): 400 - 2000 nm Time resolution (TRPL): < 1 ns
	Ellipsometry *J.A. Woollam Co. (VASE; M-2000UI; M44; IR-VASE)*	n (λ) et k (λ) , d (multilayers), roughness, uniformity, chemical bonds	1.6 – 6.0 nm 1 cm^{-1} (IR)	≤ 1 nm (model and material dependent)	3 – 10 mm	Spectral range: 245 nm – 33 µm
	Spectrophotometry *Perkin-Elmer, Lambda 19*	Specular and diffuse transmission and reflection, color, concentration (in solutions)	0.05 – 5 nm (UV-VIS) 0.2 – 20 nm (NIR)	-	2 mm	Spectral range: 175 – 3200 nm
MICROSCOPY	**SEM/EDS** *Philips XL-20* *access to a Hitachi S-4700*	Imaging and elemental microanalysis	≤ 1 at%	0.5 – 3 µm (EDS)	2 – 5 nm (SEM) ≥ 0.3 µm (EDS)	Imaging
	AFM/SPM *DI - Multimode; DI - Dimension 3100 (2X); DI - Enviroscope; Topometrix Discoverer*	Contact, non-contact, tapping, phase imaging, LFM, MFM, FMM, EFM, STM	-	0.01 nm	0.1 nm	Imaging Liquid and electrochemical cells
ACCELERATOR TECHNIQUES	**RBS** *Accelerators Tandetron 1.7 MV and Tandem 6 MV*	Depth profiling, thin film composition and thickness	0.001 – 10 at% (element atomic weight dependent)	3 nm	2 mm	-
	ERD, ERD-TOF, ERD by dE/E *Accelerator Tandem 6 MV*	Depth profiling, quatitative elemental concentration, including H	0.1 – 1 at%	10 nm	2 mm	-
	NRA *Accelerator Tandem 6 MV*	Depth profiling	0.001 at%	5 nm	2 mm	-
	Channelling *Accelerator Tandetron 1.7 MV*	Depth profiling, crystalline structure defects and locations	1 at%	5 nm	2 mm	-
	Medium Energy Ion Scattering *Accelerator 200 kV*	Depth profiling, surface atomic structure	1 at%	0.3 nm	2 mm	Clustered with MBE and XPS systems

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