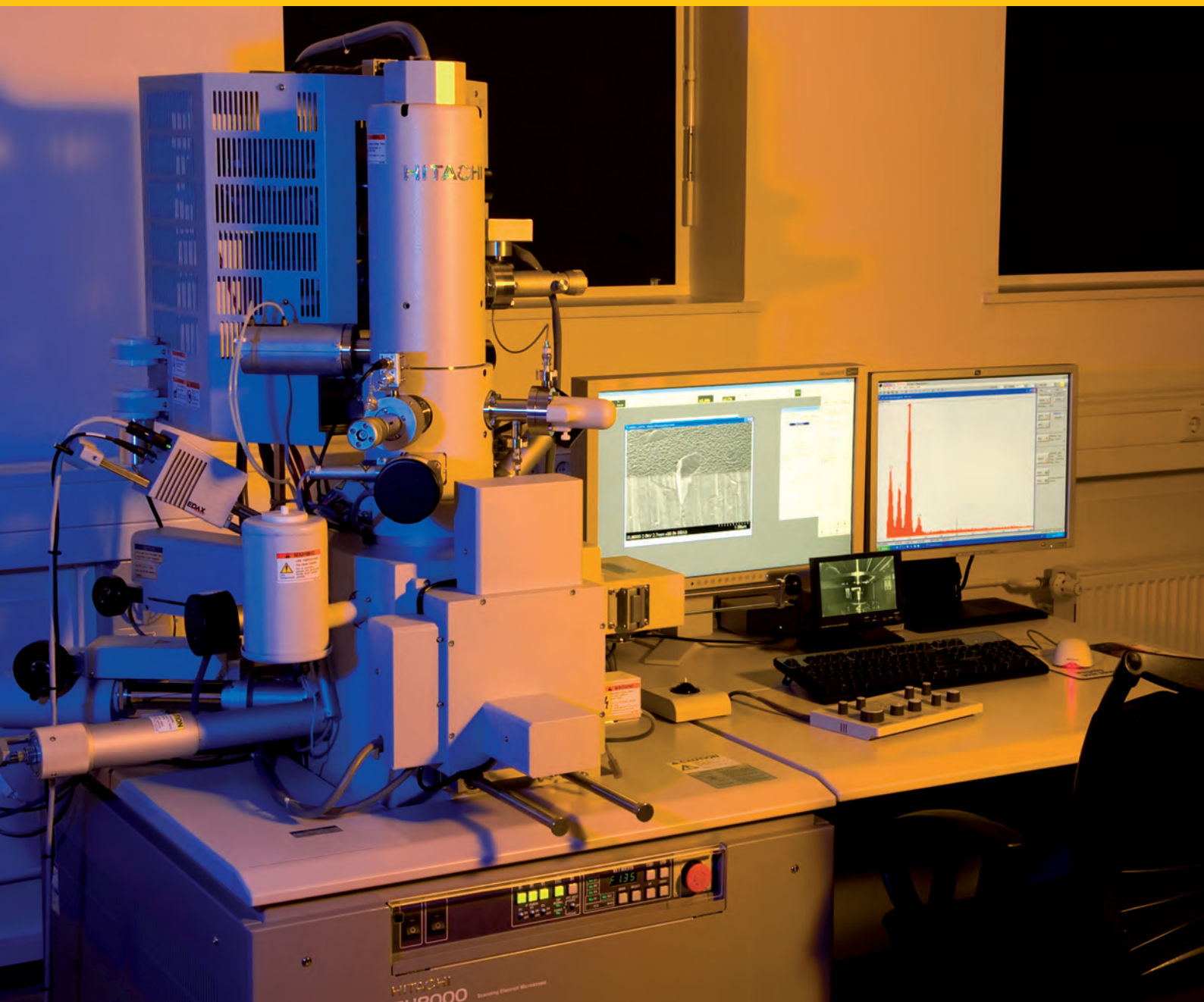
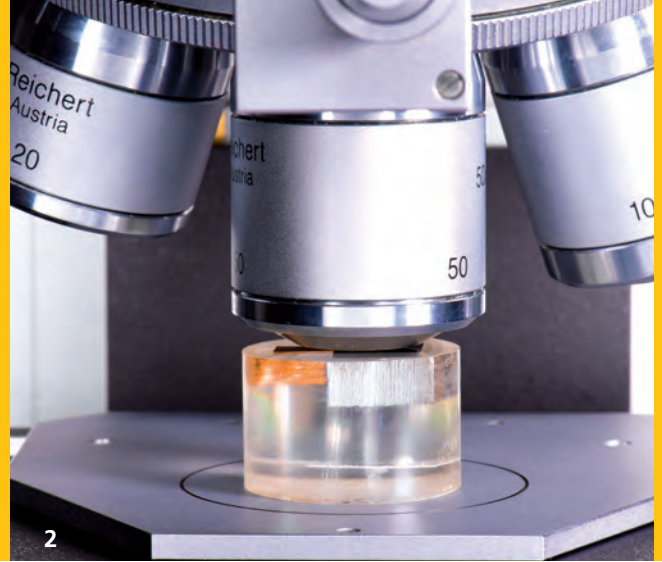
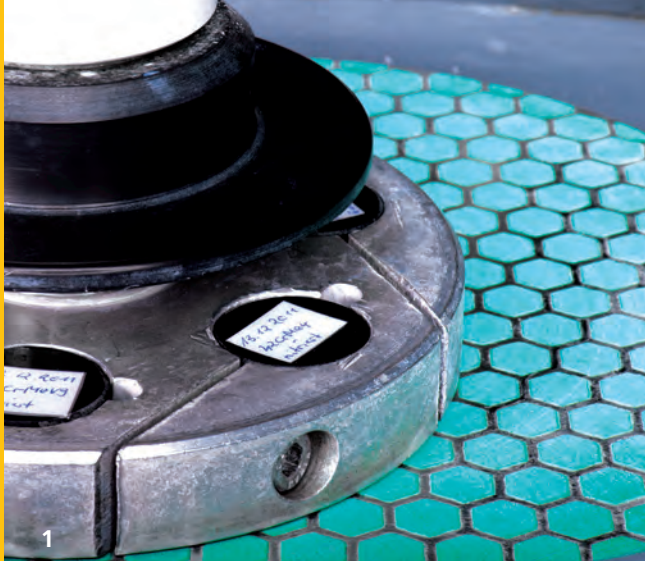


**CHARACTERIZATION  
OF THIN FILMS, SURFACES AND DEVICES**  
SERVICE FOR RESEARCH, DEVELOPMENT AND QUALITY CONTROL





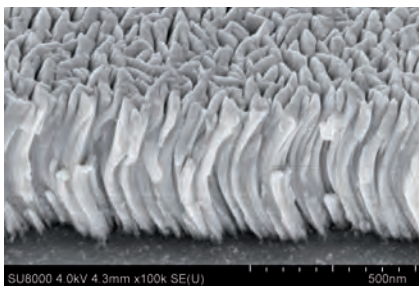
## Characterization of thin films and surfaces

The department materials analysis at Fraunhofer FEP has versatile methods for characterization of thin films and surfaces. The equipment and the wide

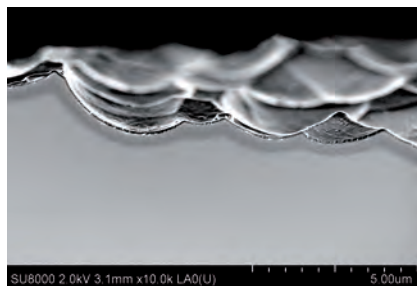
analytical experience of our staff are available for the product and technology development of our institute and are offered as a service to our customers.

Typical applications areas are layers for optics, sensor technology, displays, photovoltaic, packaging, corrosion and wear resistance.

## Structure and microstructure

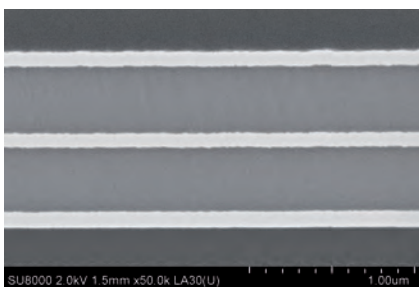


*Cross fracture and surface of a molybdenum layer (Topographic contrast)*

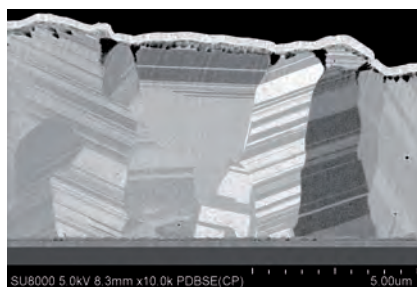


*Emitter layer of a polycrystalline silicon solar cell (Voltage contrast)*

Ultra high resolution FE scanning electron microscope, SU8000 (Hitachi)



*Ion polished cross section of a permeation barrier layer system (Material contrast)*

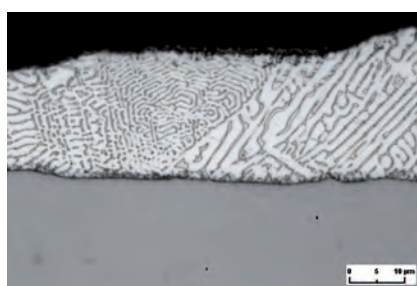


*Ion polished cross section of a CdTe solar cell (Crystal orientation contrast)*

Ion preparation technique for cross sections, Cross Section Polisher, SM-09010 (JEOL)



*Metallographic cross section of a copper layer*



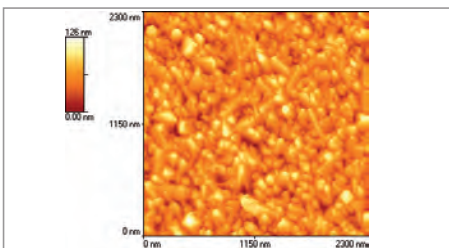
*Metallographic cross section of a magnesium-zinc alloy layer*

Metallographic preparation technique and optical microscope Polyvar 2 Met (Reichert)

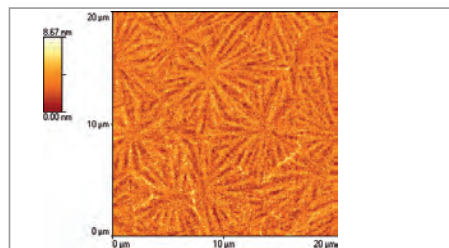




## Topography

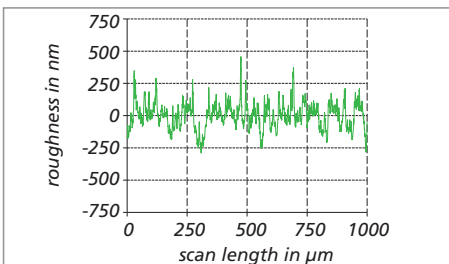


Surface of a FTO layer with typical crystallite morphology

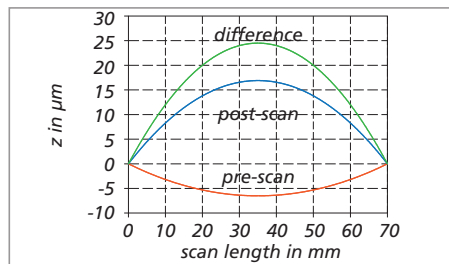


Surface of a (Ti,Nb) $O_x$  layer with spherulitic crystallites

Atomic force microscope (AFM) Explorer (Topometrix)



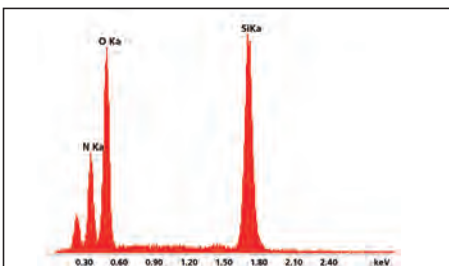
Roughness scan of a steel sheet



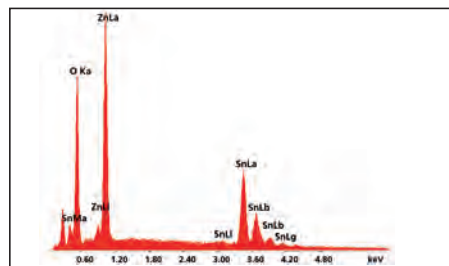
Stress determination of thin layers from curvature

Surface profiler P15-LS (TENCOR)

## Chemical composition

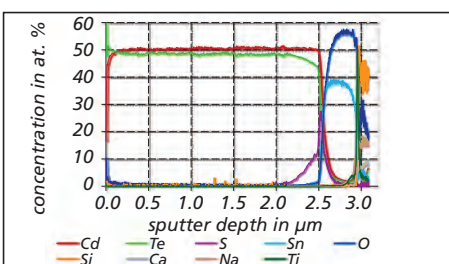


EDS spectrum of a  $SiO_xN_y$  layer

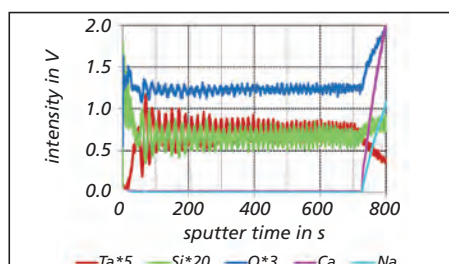


EDS spectrum of a (Zn, Sn) $O_x$  layer

Energy-dispersive X-ray spectroscopy (EDS)  
SDD detector Apollo XV (EDAX)

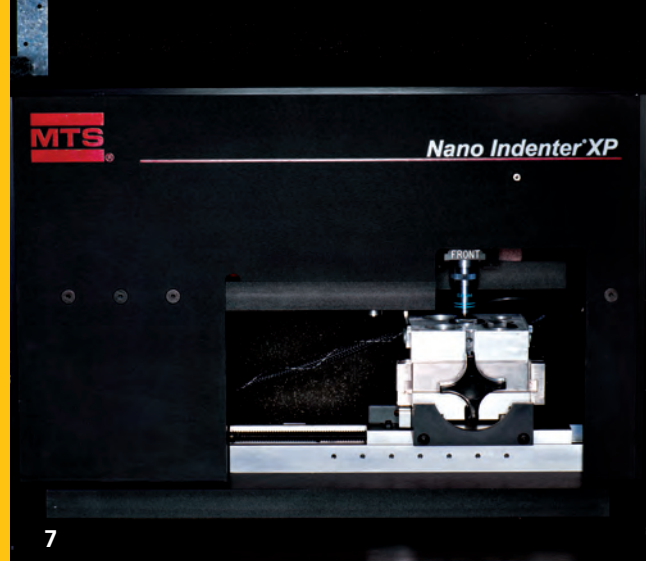


Chemical depth profile of a CdTe thin film solar cell



Chemical depth profile of an optical rugate filter

Glow discharge optical emission spectroscopy (GD-OES)  
GD-Profilier 2 (HORIBA Jobin Yvon)



## Layer properties

Optical	Mechanical	Electrical
<ul style="list-style-type: none"> <li>spectroscopic ellipsometry (SE850, Sentech)</li> <li>UV VIS spectroscopy (Lambda 950, Perkin Elmer)</li> <li>haze measurement (Haze-guard plus, BYK-Gardner)</li> </ul>	<ul style="list-style-type: none"> <li>hardness and indentation modulus (Nano Indenter XP, MTS)</li> <li>abrasion resistance (Taber Abraser)</li> <li>scratch adhesion test (MST4, CSEM)</li> <li>layer thickness (Calotest, CSEM)</li> </ul>	<ul style="list-style-type: none"> <li>I-V curve of solar cells (Sun 300, LOT)</li> <li>quantum efficiency (Oriol IQE-200, Newport)</li> <li>photo and dark conductivity (SUSS Prober und Keithley)</li> <li>electrical four point probe (FPP 5000, Veeco)</li> </ul>
Permeation barrier	Corrosion	Environmental
<ul style="list-style-type: none"> <li>water vapour permeability (WDDG, Brugger Feinmechanik; HiBarSens 2.0 HT, Sempa)</li> <li>electrical and optical Calcium test</li> <li>oxygen permeability (OX-TRAN 2/20, Mocon)</li> </ul>	<ul style="list-style-type: none"> <li>corrosion test system for condensation water test and salt spray test (SKB 400 A-SC, Liebisch)</li> </ul>	<ul style="list-style-type: none"> <li>environmental chamber - 40 ... +150°C; adjustable humidity (SH-241, ESPEC)</li> </ul>

## TITLE PHOTO

*FE scanning electron microscope SU8000 (Hitachi)*

**1** *Metallographic preparation technique (Struers)*

**2** *Optical microscope Polyvar 2 Met (Reichert)*

**3** *Atomic force microscope Explorer (Topometrix)*

**4** *Surface profiler P15-LS (TENCOR)*

**5** *Glow discharge optical emission spectrometer GD-Profilier 2 (HORIBA Jobin Yvon)*

**6** *Spectroscopic ellipsometer SE850 (Sentech)*

**7** *Nano Indenter XP (MTS)*

## Fraunhofer Institute for Organic Electronics, Electron Beam and Plasma Technology FEP

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8



9



10



11

## Our offer

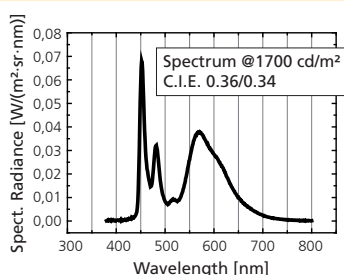
- analytical services for analysis of the effect of process parameters on structure and microstructure, topography, chemical composition and properties of thin films
- support of our customers for quality control and failure analysis
- technical advice for selection and combination of suitable analysis methods
- development of analysis methods for specific applications and measurement tasks

- 8 Water vapour permeability tester (Brugger)
- 9 Calotest (CSEM)
- 10 Abrasion resistance (Taber Abraser)
- 11 Electrical conductivity (SUSS Prober und Keithley)

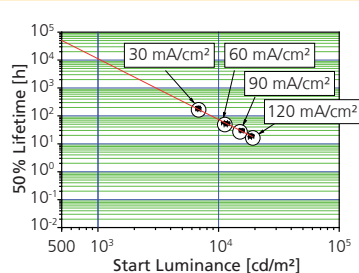
## Electro-optical device characterization

- electro-optical characteristic within the visible range (380 to 800 nm) including spectral and angular distribution
- luminance, quantum efficiency, luminous efficacy, color temperature, and color point (e.g. following CIE1931)
- homogeneity of the luminance on large area
- direct measurement of the absolute luminous flux for panels up to about 1000 cm<sup>2</sup> active area
- high resolution IR images on large area
- transmission and reflection in the visible and near-infrared range
- emission and excitation spectra of organic materials within a spectral range of 200 to 850 nm
- determination of the luminance degradation, color shift as well as the drop-down rate of OLED devices under long-term operation
- long-term measurements under standardized climatic conditions for the determination of the shelf lifetime of OLED devices
- solar cell characterization (solar simulator, photocurrent-mapper MP15)

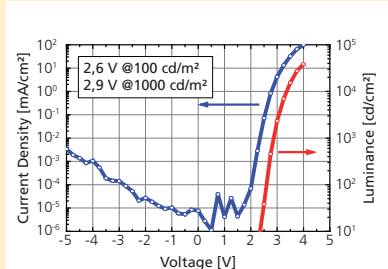
### OLED spectra



### Determination of operational lifetime



### Luminance- / Current-voltage characteristic





*We focus on quality  
and the ISO 9001.*