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

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

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

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

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

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

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

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

Metallographic cross section of a copper layer

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

- Atomic force microscope (AFM) Explorer (Topometrix)

- Surface of a FTO layer with typical crystallite morphology

- Surface of a (Ti,Nb)Ox layer with spherulitic crystallites

- Roughness scan of a steel sheet

- Stress determination of thin layers from curvature

**Chemical composition**

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

- EDS spectrum of a SiOxNy layer

- EDS spectrum of a (Zn, Sn)Ox layer

- 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-Profiler 2 (HORIBA Jobin Yvon)
### Layer properties

<table>
<thead>
<tr>
<th>Optical</th>
<th>Mechanical</th>
<th>Electrical</th>
</tr>
</thead>
<tbody>
<tr>
<td>• spectroscopic ellipsometry</td>
<td>• hardness and indentation modulus</td>
<td>• I-V curve of solar cells</td>
</tr>
<tr>
<td>(SE850, Sentech)</td>
<td>(Nano Indenter XP, MTS)</td>
<td>(Sun 300, LOT)</td>
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<tr>
<td>• UV VIS spectroscopy</td>
<td>• abrasion resistance</td>
<td>• quantum efficiency</td>
</tr>
<tr>
<td>(Lambda 950, Perkin Elmer)</td>
<td>(Taber Abraser)</td>
<td>(Oriel IQE-200, Newport)</td>
</tr>
<tr>
<td>• haze measurement</td>
<td>• scratch adhesion test</td>
<td>• photo and dark conductivity</td>
</tr>
<tr>
<td>(Haze-guard plus, BYK-Gardner)</td>
<td>(MST4, CSEM)</td>
<td>(SUS Prober und Keithley)</td>
</tr>
<tr>
<td></td>
<td>• layer thickness</td>
<td>• electrical four point probe</td>
</tr>
<tr>
<td></td>
<td>(Calotest, CSEM)</td>
<td>(FPP 5000, Veeco)</td>
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### Permeation barrier

<table>
<thead>
<tr>
<th>Corrosion</th>
<th>Environmental</th>
</tr>
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<tbody>
<tr>
<td>• water vapour permeability</td>
<td>• environmental chamber</td>
</tr>
<tr>
<td>(WDDG, Brugger Feinmechanik; HiBarSens 2.0 HT, Sempa)</td>
<td>-40 ... + 150°C; adjustable humidity</td>
</tr>
<tr>
<td>• electrical and optical Calcium test</td>
<td>(SH-241, ESPEC)</td>
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<tr>
<td>• oxygen permeability</td>
<td></td>
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<tr>
<td>(OX-TRAN 2/20, Mocon)</td>
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<tr>
<td>• corrosion test system for</td>
<td></td>
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<tr>
<td>condensation water test</td>
<td></td>
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<tr>
<td>and salt spray test</td>
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<td>(SKB 400 A-SC, Liebisch)</td>
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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

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 cm² 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](image)

![Determination of operational lifetime](image)

![Luminance-/ Current-voltage characteristic](image)
We focus on quality and the ISO 9001.