

research, develop, measure.
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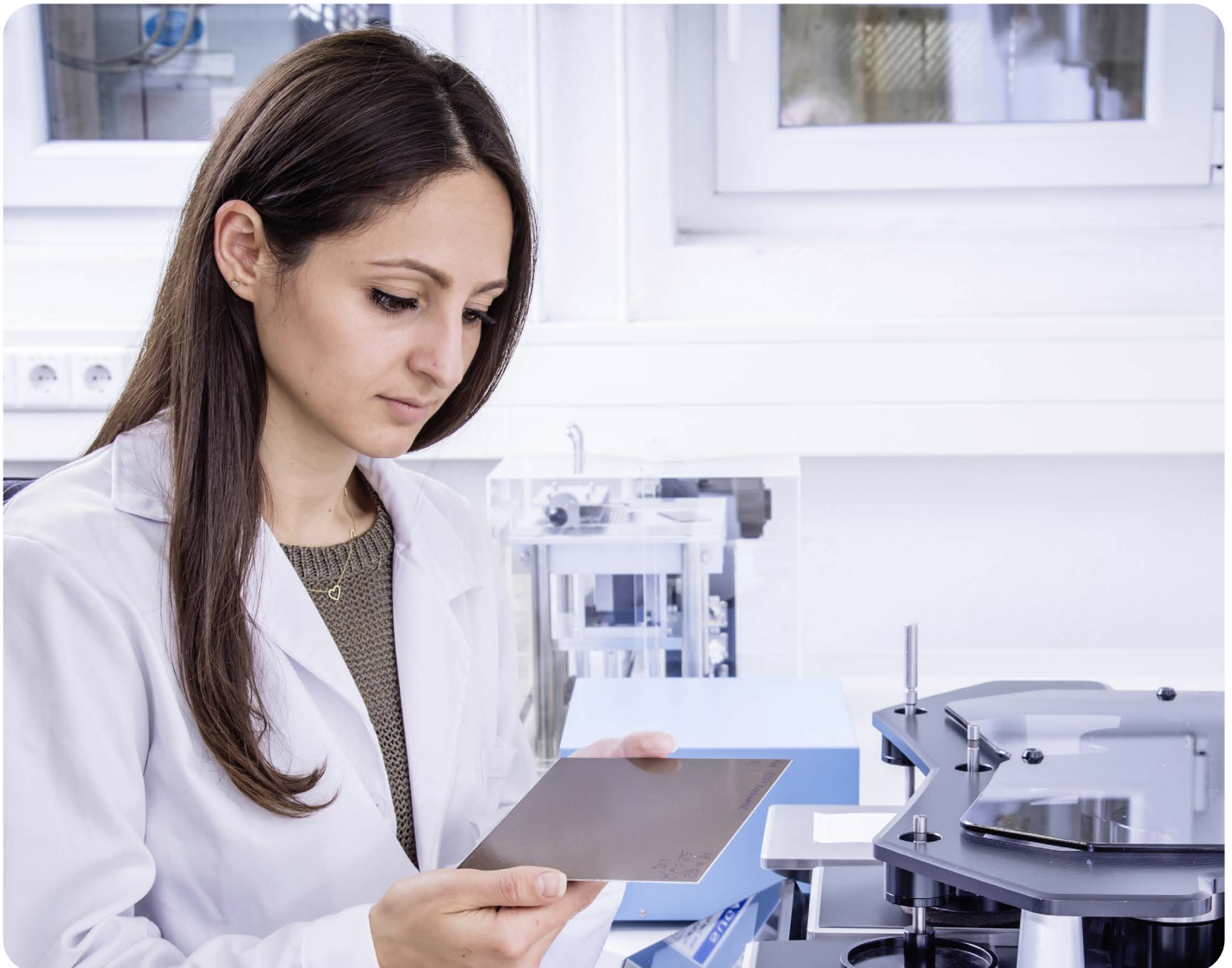


MEASURE

Test, analyze, and characterize

Whether it involves the development of new products, quality assurance, or damage to components, fem offers all the necessary testing methods for investigating material and coating properties. These include hardness measurements, tensile and compression tests, corrosion and weathering tests, chemical analyses, tribological tests, 3D X-ray CT, scanning electron microscopy, and much more.

For more information, please visit [fem-institute.com](https://www.fem-institute.com)



COATING PROCESSES

Electroplating and chemical coating

Modeling and simulation, pattern coating, specialized processes: alloy deposition, dispersion deposition, pulse plating, rotating electrode, electroforming

Anodic oxidation

Pre-treatment processes, anodizing, pad anodizing, dip dyeing, electrolytic dyeing processes, hard anodizing, plasma anodizing, electrophoretic deposition, multi-layer anodizing

PVD/PACVD-methods

Magnetron sputtering (HIPIMS, MF, DC), cathodic arc evaporation, plasma arc chemical vapor deposition (PACVD), plasma immersion ion implantation (PIII)

Painting Techniques/Surface Preparation

Liquid paint coating, powder coating, radiation-curing coatings (UV/IR), whirl sintering

MATERIAL AND LAYER CHARACTERIZATION

Computed tomography

Failure Analysis, Dimensional Measurement

Coating thickness

X-ray fluorescence analysis (XRF), cross-section, magnetic methods, eddy current testing, Calotest, profilometry, coulometry, STEP test

Coating composition

GDOES, scanning electron microscopy (SEM) with energy-dispersive X-ray spectroscopy (EDX), X-ray fluorescence analysis (XRF)

Structure

Field-emission scanning electron microscopy (SEM), FIB, crystal structure and microstructural analysis (EBSD)

X-ray diffraction (XRD)

Phase identification, quantitative phase analysis, microstructure analysis (crystal size), examination of thin sections using grazing incidence, measurement of residual stresses, determination of textures

X-ray reflectometry (XRR)

Coating thickness (5–200 nm), density measurement

Surface roughness and topography measurement

Tactile profilometry, confocal microscopy, 3D digital microscopy

Hardness

Microhardness, ultramicrohardness, Buchholz hardness, instrumented indentation testing (indentation or Martens hardness), hardness profiles and hardness maps, correlative hardness and EDX mapping, Vickers, Knoop, Brinell, Rockwell, pendulum hardness, Mohs hardness

Internal tensions

X-ray diffraction, in situ analysis with MSM 200

Ductility

Bending test, mandrel bending test, tensile test

Adhesion strength

Scratch test, ball impact test, indentation test, mandrel bending test, thermal cycling test, cross-cut test, soldering and bonding methods, Rockwell indentation test, peel strength (per ASTM C 633), tear test (per ISO 4624)

Friction, wear

Pen-disc tribometer, oscillating wear, Taber abraser, scratch resistance, cleaning resistance, Martindale test, abrasive wheel

Color, Gloss, Transmission

Simultaneous spectrometer, gloss measurement according to Reimann (goniophotometer), transmission measurement, spectrophotometer (45/0, spin, spex), appearance measurement (DoI, orange peel, etc.), triangular gloss measurement

Corrosion

Spray mist (NSS, AASS, CASS), condensation tests, cyclic corrosion testing, filiform corrosion, complex corrosion-climate cycling tests, CD test, electrochemical measurements, artificial sweat, nickel susceptibility, tarnish test

Light and weather resistance

Artificial weathering, outdoor weathering

Coating-specific tests

Pressurized water jet test, multi-impact test, chemical resistance, penetration test

Electrical Properties

Electrical conductivity (Sigmascope SMP350), contact resistance on passivation layers/bipolar plates/contact materials, determination of sheet resistance (layer resistance), breakdown voltage, apparent conductivity

Thermal Properties

Thermal shock, glass transition temperature, melting point, environmental testing, aging, thermal cycling testing

MATERIAL TESTING AND DEVELOPMENT

Electron microscopy

STEM with EDX, WDX, FIB, EBSD, and STEM detectors; TEM sample preparation (dimpling, electrolytic polishing, FIB); ion polishing

Metallographic methods

Optical microscopy with image analysis, coating thickness (cross-section), phase composition, particle size analysis, pore analysis, particle incorporation rate

Technical tests

Friction, Wear, Deep Drawing Tests

Mechanical tests

Hardness (Vickers, Rockwell, Brinell, Knoop), tensile strength, compressive strength, high-temperature testing, stress relaxation

Physical methods

3D X-ray computed tomography, X-ray diffractometer, measurement of electrical/magnetic properties, contact angle, thermal analysis (differential thermal analysis (DTA), calorimetry (DSC), thermogravimetry (TG), dilatometry)

Metallurgy Lab

Alloy production: vacuum arc furnace, vacuum induction furnace, vacuum die casting, vacuum centrifugal casting, vacuum tilting casting; mold casting: permanent mold casting, continuous casting, precision casting; heat treatment under inert gas and vacuum; Vacuum hot press, rolling, round hammering, wire drawing

Additive Manufacturing and Powder Metallurgy

Ultrasonic plasma atomizer, additive manufacturing with process monitoring, process optimization, alloy development, microstructure-property correlation, vacuum hot press, powder production, powder characterization

Simulation

Phase diagrams (thermodynamics, material properties), diffusion processes, process simulation (heat treatment, casting, additive manufacturing), electrochemical deposition processes

ANALYTICS

Material analysis, damage cases, recycled and scrap materials

ICP-OES, ICP-MS, X-ray fluorescence (ED-XRF, WD-XRF), carbon/sulfur and oxygen/nitrogen analysis, UV-VIS and IR spectroscopy, IR microscopy, chromatography (GC, IC), precious metal analysis (assay), Total organic carbon (TOC), total organic sulfur (AOX), DSC, polarization measurement, GDOES, metal analysis, alloy analysis, trace element analysis

Electrolyte characterization

Cyclic voltammetry (CV), cyclic stripping voltammetry (CVS), electrolyte parameters

Cell characterization

Cycling, cyclic voltammetry (CV), electrochemical impedance spectroscopy (EIS), testing of individual cells and stacks on fuel cell and electrolysis test benches (I-V curves, CV, EIS, long-term behavior)