



# Physical Metallurgy · Material Testing Precious Metals Research



We examine and characterize metallic materials and develop new alloys, functional materials and processes for industrial practice



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Physical Metallurgy belongs to the founding departments of the fem. Central tasks of the department are the production, processing and metallurgical testing and characterization of metallic materials for the jewelry, dental or electrical industry. This includes alloys and composite materials whose structures and microstructures are examined in terms of mechanical, thermal and functional properties. Particular attention is paid to the relationship between production, processing and loading of materials and alloys in practical use.

## Research and Development

- > New alloys and functional materials
- > Tempering mechanisms of metals
- > Exploration of casting procedures
- > Innovative production methods
- > Joining technology and solder materials
- > Material testing and characterization

## Services

- > Damage analysis, consultation and expert reports
- > Optical and scanning electron microscopy
- > Metallographical examinations
- > Testing of mechanical properties
- > Examination of layers and coatings
- > Accredited according to DIN EN ISO/IEC 1702

## Equipment and Procedures

- > New Metallurgical Laboratory
- > Electric arc and induction furnace
- > Vacuum investment casting
- > Additive Manufacturing
- > High resolution Field Emission Scanning Electron Microscopy (FE-SEM)
- > Focused Ion Beam (FIB)
- > Thermal analysis
- > Universal testing machine

## DEPOSITION TECHNOLOGIES

### Electroplating and electroless plating

Pulse plating, high-speed deposition, tampon plating, rotating disc electrode, electroforming, electrodeposition from ionic liquids, modelling and simulation of electrochemical cells and processes

### Anodisation

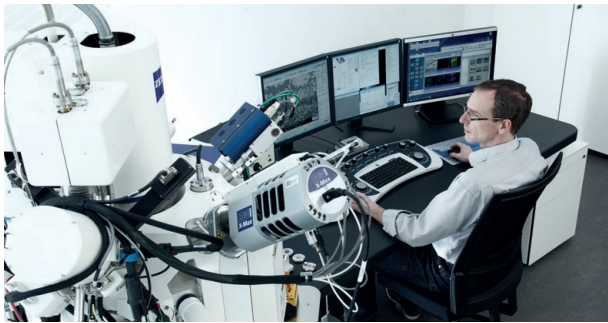
Pretreatment procedures, anodising, tampon anodisation, dip coloring, electrolytic coloring

### PVD/PACVD

Magnetron sputtering (HIPIMS/HPPMA, MF, DC), arc deposition, PACVD: plasma assisted deposition, pulsed CVD

### Lacquering

Liquid lacquers, powder lacquers, radiation hardening lacquers (UV/IR), vortex sintering



## CHARACTERIZATION OF MATERIALS AND COATINGS

### Coating thickness

Coulometry, X-ray fluorescence, Ni-STEP-test, magnetic methods, eddy current, metallographic cross section, calotest, profilometry

### Coating composition

GDOS, scanning electron microscopy (SEM) with energy dispersive X-ray analysis (EDX)

### Structure, morphology

High resolution field emission SEM, SEM, FIB, crystal structure and microtexture analysis (EBSD)

### X-ray diffraction (XRD)

Phase identification, quantitative phase analysis, determination of microstructure (crystallite size), investigation of thin films with grazing incidence, measurement of residual stresses, determination of textures

### X-ray reflectometry (XRR)

Layer thickness (5–200 nm), density determination

### Roughness, topography

Diamond stylus and laser stylus profilometry, Confocal microscopy, 3D defect analysis

### Hardness

Microhardness, ultra-low load hardness, Buchholz hardness, instrumented indentation test (indentation and Martens hardness)

### Internal Stress

X-ray diffraction, MSM 200

### Ductility

Cupping test, bend test, tensile test

### Adhesion

Cross cut, ball impact test, cupping test, bend test, thermal cycle test, soldering test, adhesive bonding test, Rockwell indentation test, adhesive tensile strength (ASTM C 633), tear test (ISO 4624)

### Friction, wear

Pin-on-Disk, taber abraser, scratch resistance, resistance to cleaning

### Color, gloss, transmission

Simultaneous spectrometer, Reimann gloss measurement (goniophotometer), transmission measurement, spectrophotometer (45/0, spin, spex), appearance measurement (DoI, Orangepeel, etc.), triangle gloss measurement

### Light and weather proof

Artificial weathering, natural weathering

### Corrosion

Artificial perspiration, nickel test, ammonia test, electrochemical tests, salt spray tests (NSS, AASS, CASS), humidity tests, climate tests, alternating tests, cyclic corrosion tests, filiform corrosion, complex corrosion-climate change test

## MATERIALS TESTING

### Electron microscopy

FE-SEM with EDX, FIB, EBSD and STEM-detector, preparation of TEM-samples, ion polishing

### Metallography

Optical microscopy with image analysis, coating thickness (cross section)

### Technological methods

Friction, wear, cupping tests

### Mechanical methods

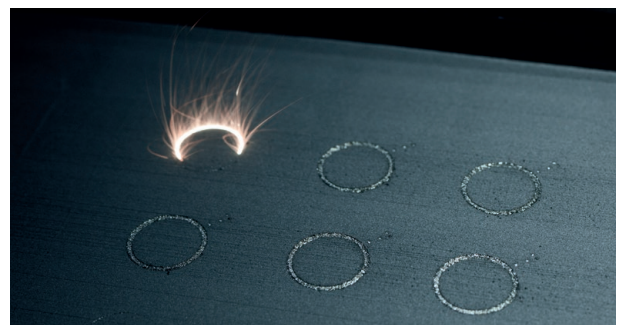
Hardness (Vickers, Rockwell, Brinell), tensile test, compression test

### Physical methods

3d x-ray computed tomography (CT), x-ray diffractometry, measuring of magnetic and electrical properties, contact angle, differential thermal analysis (DTA), calorimetry (DSC), thermal gravimetry (TG), dilatometry

### Melting and heat treatment

Arc furnace, induction furnace, rapid quenching, annealing furnace (vacuum and protective gas), investment casting (lost wax technique), centrifugal casting



## ANALYTICS

### Materials analysis, Failure analysis, Recycling, Shedding goods

ICP-OES, AAS, X-ray fluorescence, Carbon/sulphur and oxygen/nitrogen determination, UV-VIS and IR-Spektroskopie, IR-Microscopy, Chromatography (GC, GC-MS, HPLC, IC), Precious metal determination (docimasy), sum parameter (TOC, AOX), DSC, polarization measurement

### Characterization of electrolytes

Cyclovoltammetrie (CV), Cyclic Voltammetric Stripping (CVS)

### Computed Tomography

Damage and failure analysis, dimensional measurement