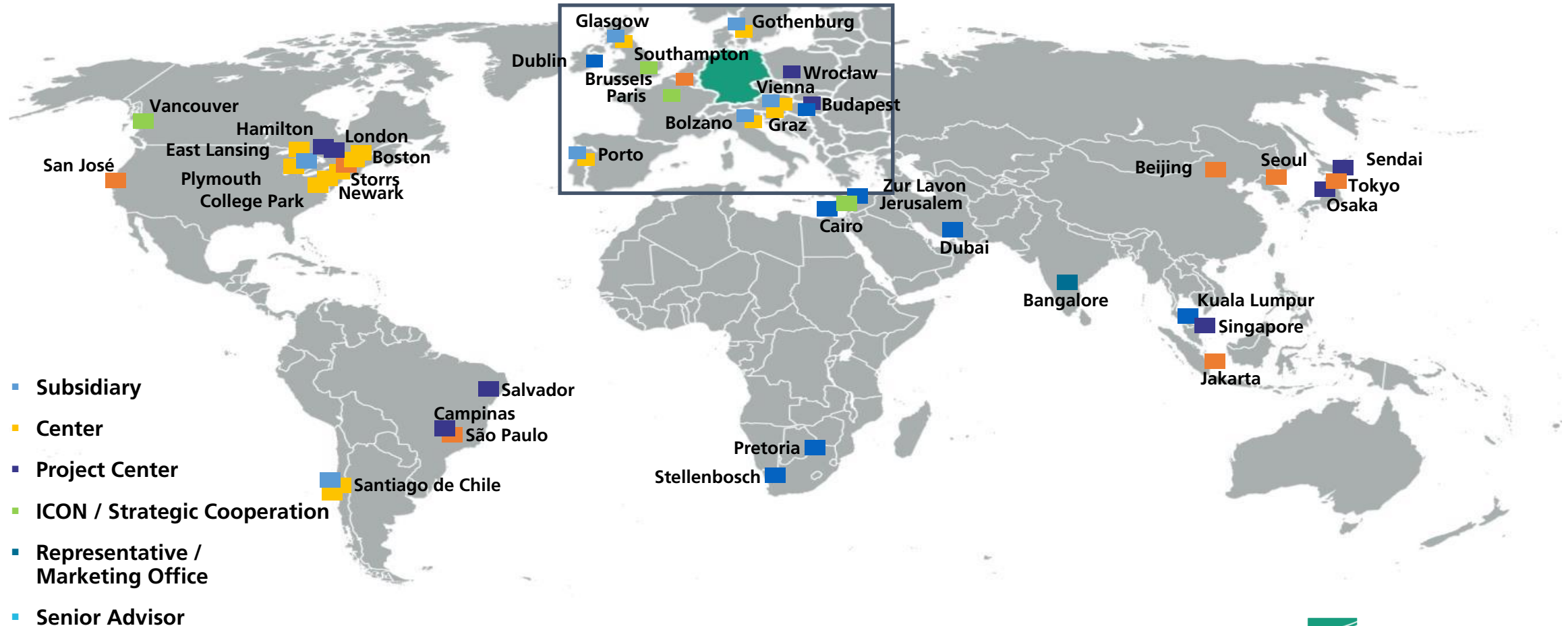


Ort | Datum | Anlass

Fraunhofer ISC – materials and processing expertise

GRAND CHALLENGES NEED VALUE ADDED SOLUTIONS

The Fraunhofer-Gesellschaft – leading institution for applied research in Europe



The Fraunhofer-Gesellschaft – locations in Germany

- 72 Institutes
- 25.000 staff
- Budget:
more than 2.3 Mrd € (incl. 2 Mrd € from contract research)



→ Fraunhofer Institute for Silicate Research ISC

That's Fraunhofer ISC ...

SPECIALISTS IN MATERIAL, PROCESS AND PROTOTYPE DEVELOPMENT
FOR ENERGY, ENVIRONMENT AND HEALTH



Fraunhofer-Institute for
Silicate Research ISC

»» Würzburg | Bronnbach



Fraunhofer-Center for High
Temperature Materials and
Design HTL

»» Bayreuth | Würzburg



Fraunhofer Project Group
Materials Recycling and
Resource Strategies IWKS

»» Alzenau | Hanau

... Faces



Prof. Dr. Gerhard Sextl
»» Director Fraunhofer ISC



Dr. Thomas Hofmann
»» Managing Director



Dr. Michael Popall
»» ISC International



PD Dr. Friedrich Raether
»» Director Center HTL



Prof. Dr. Rudolf Stauber
»» Director
Project Group IWKS



PD Dr. Marco Metzger
»» Acting Director TLZ

... Facts

480 employees (2017)
(350 permanent)

5 locations:
Würzburg | Alzenau |
Hanau | Bayreuth |
Bronnbach
with approx. 10 000 m²
lab and technical space

2 Application Centers:
Aschaffenburg | Hof



35,2 Mio Budget (2017):

5,3 Mio Invest
8,3 Mio Contract
venue (industry)
12,6 Mio Project funding
(nat. | internat.)

8,6 Mio Public funding

in Euro



SUBJECT: MATERIALS MEET
...

... ENERGY

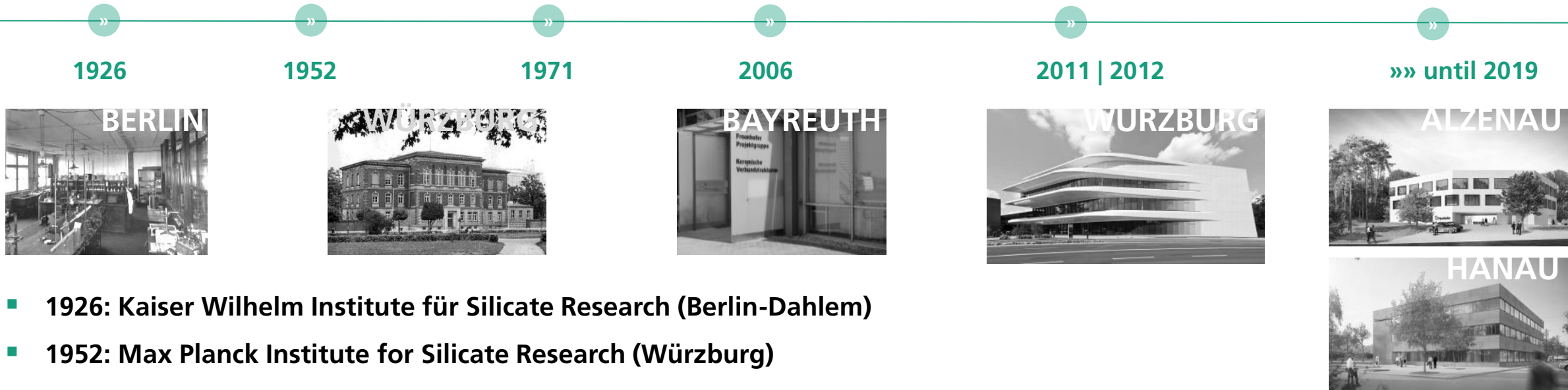
... RESOURCES

... BIOMEDICINE

... CLEAN ENVIRONMENT

... ADAPTIVE SYSTEMS

... History



- 1926: Kaiser Wilhelm Institute für Silicate Research (Berlin-Dahlem)
- 1952: Max Planck Institute for Silicate Research (Würzburg)
- 1971: Fraunhofer Institute for Silicate Research ISC (Würzburg)
- 2006: Launch Project Group in Bayreuth, since 2012 Fraunhofer Center for High Temperature Lightweight Design HTL
- 2011: Launch Project Group for Materials Recycling and Resource Strategies IWKS in Alzenau; 2012: expansion to Hanau
- 2017: Groundbreaking for new tech and lab buildings in Alzenau, Hanau und Bayreuth
- 2017: Integration of Translational Center for Regenerative Therapies TLZ-RT

... Future

MATERIALS MEET...

...ENERGY

- More efficiency in thermal processing
- Safe and high-performance energy storage
- More efficiency in energy conversion

...RESSOURCES

- Efficient use of renewables
- Biobased | biocompatible | biodegradable materials
- Substitution and recycling of critical materials

...BIOMEDICINE

- Regenerative therapies
- Tissue based modelling
- Process automation
- Stem cell processing

... Competences

MATERIALS

- Glass | ceramics | hybrids | (bio)ORMOCER®s
- Bioactive materials
- Battery materials
- Magnetic materials
- Smart materials
- High-temperature materials



PROCESSING

- Micro-/nanoparticles
- Fibers
- (Wet) coatings (R2R | dip | spin | etc.)
- 3D/2D structurization | 3D printing
- Tissue engineering
- Clean rooms | GMP like facilities
- Demonstrators | pilot plants | automation



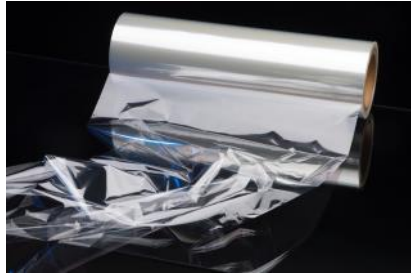
ANALYTICS

- Materials characterization (starting from atomic scale)
- Failure analysis
- Quality control
- In situ test equipment
- Human 3D in-vitro testing models

... Development partners

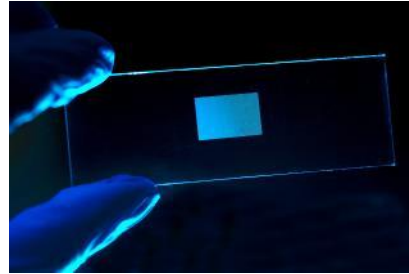


... Solutions



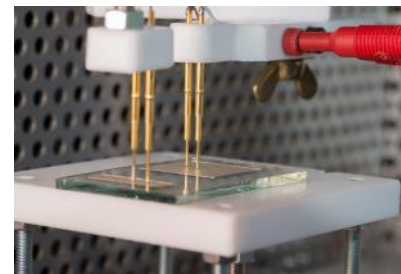
Materials Chemistry

- Multifunctional coatings | lacquers (anti-X, barrier...)
- Biodegradable lacquers (→ packaging)
- Functional particles
- Magnetic materials



Application Technology

- Micro optics
- Electronics
- Specialty glass
- Dental | micro medicine
- Energy materials and light weight construction



Electromobility

- Battery materials and components
- Pilot manufacture
- Testing
- Post mortem Analysis



Services

- Applied analytics
- Device development
- Cultural heritage preservation

... Solutions



Tissue Engineering

- Bioactive materials
- Tissue models
- Regenerative therapies, regulatory affairs



High-temperature applications

- (Polymer) ceramics
- Manufacturing | component design
- Process optimization
- 3D-printing (metal-) ceramic composites



Ressources and Recycling

- Biogenic systems
- Urban mining
- Ressource strategies
- Separation and sorting technologies



Smart Materials

- Adaptive materials
- Silicones
- Sensors | actuators
- Energy harvesting

BRANCHES



Translational Center for Regenerative Therapies TLZ-RT



© K. Dobberke, Fraunhofer ISC

Biomaterials | bioreactors | lab automation

Design of biologized materials and implants

Theranostics

Test systems and 3D tissue models

Standardized test systems

Cell-based disease models

hIPS technology

Clinical development

Implants / GMP

Preclinical phase / GLP

Fraunhofer Center for High Temperature Materials Design HTL



© K. Dobberke, Fraunhofer ISC

High temperature materials

Material design

Ceramics | fibers | composites | coatings

Manufacturing processes

Textile processing technologies

Forming

Thermal processes

Test firing

Components

Component design

CMC components

3D printing

Project Group

Materials Recycling and Resource Strategies IWKS



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Resource strategy

- Criticality studies
- Material flow review, life cycle assessment
- Resource management

Functional materials

- Magnetic materials
- Energy materials | lightweight technologies
- Analytics

Secondary raw materials

- Urban mining
- Biogenic systems
- Separation and sorting

UNITS HEADQUARTER



Materials Chemistry

- **Material | lacquer synthesis and processing**
- **Particle technology**
- **Coating technology**
- **Molding technology**
- **3D structurization, patterning**
- **Additive processing | 3D printing**
- **Upscaling and manufacture up to pilot scale**



Application Technology

- Glass (specialty glass development | manufacture | characterization and analysis | glass refinement | lacquers | functional coatings | fibers and capillary tubes)
- Optics and electronics (materials and process development for: printed and/or transparent electronics | flexibles for smart systems | resists | protective lacquers | 3D laser direct writing by TPA processing)
- Dental and micro medicine (hybrid materials for dental preservation and prosthesis | 3D-printing | biologization)

Services



CENTER OF APPLIED ANALYTICS

- Accredited to DIN EN ISO/EC 17025, advanced materials preparation and analysis
- RAL and EUCB testing laboratory

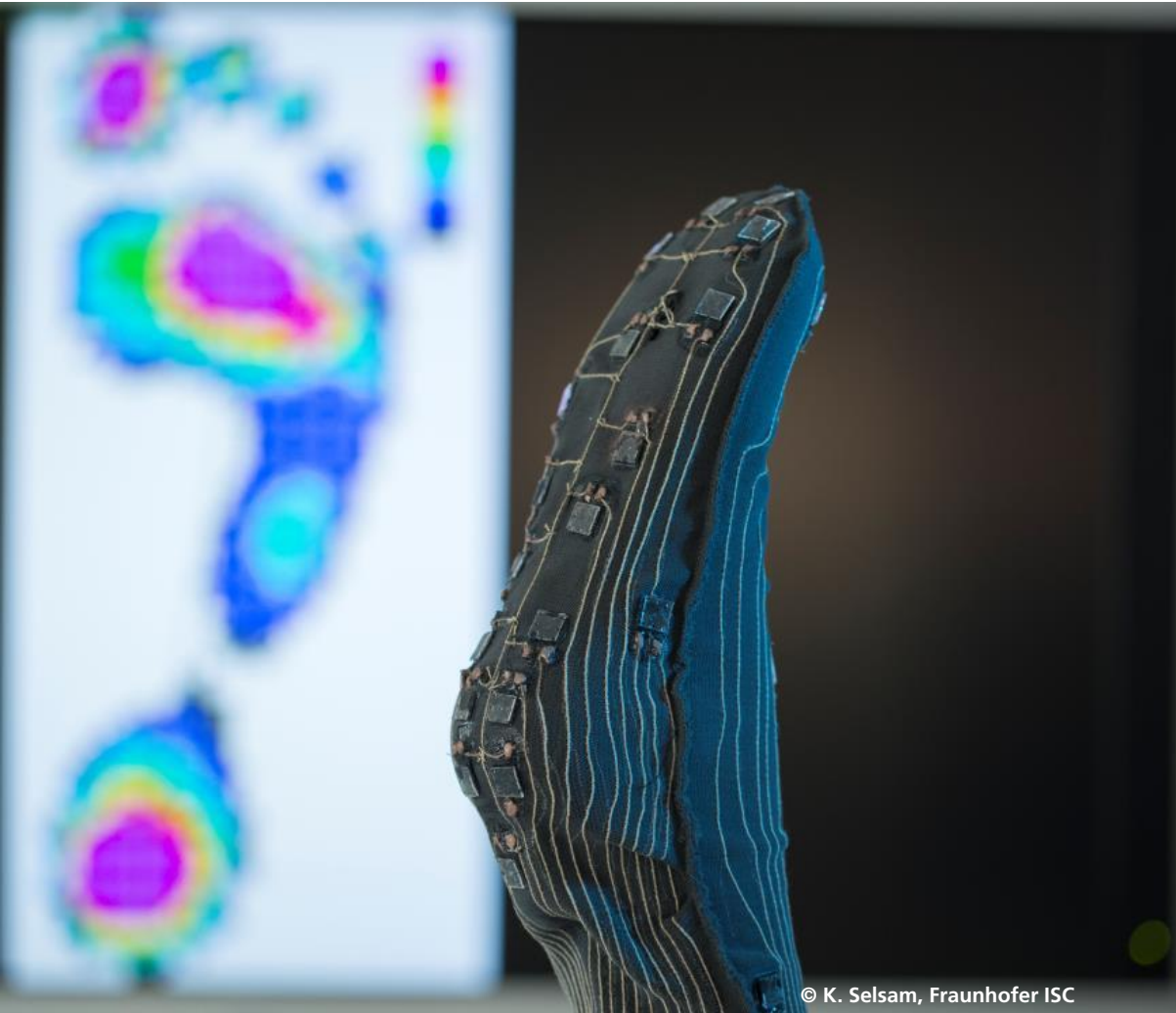
CENTER OF DEVICE DEVELOPMENT

- Special device and pilot plant development for research issues
- Volumetric calibration, thermo-optical measurement, automation of measuring and quality control

CULTURAL HERITAGE PRESERVATION

- Concepts and materials for preservation and restoration
- International Convention Center for Cultural Heritage Preservation IZKK – educational platform, harnessing latest research for restoration

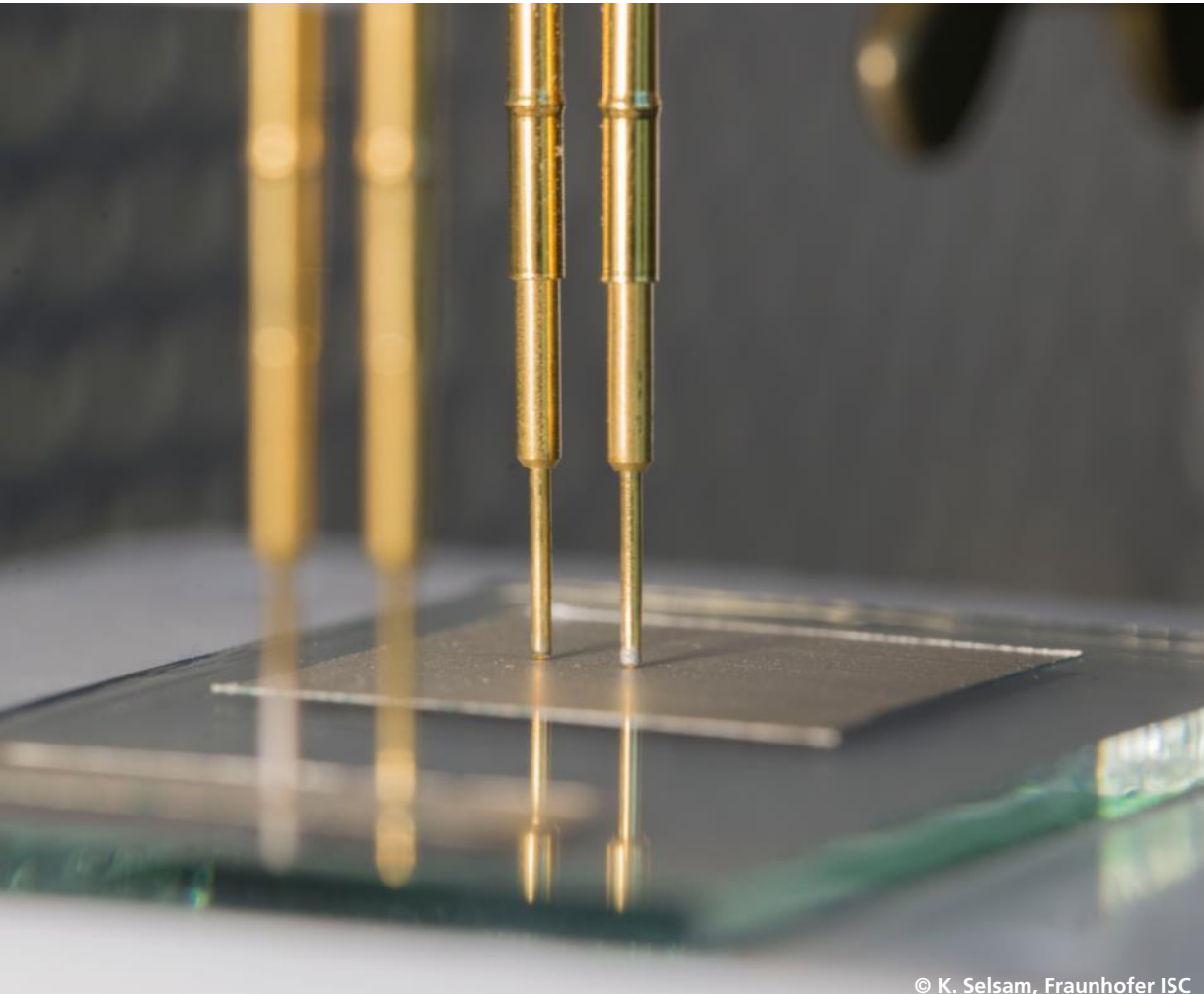
Center Smart Materials



© K. Selsam, Fraunhofer ISC

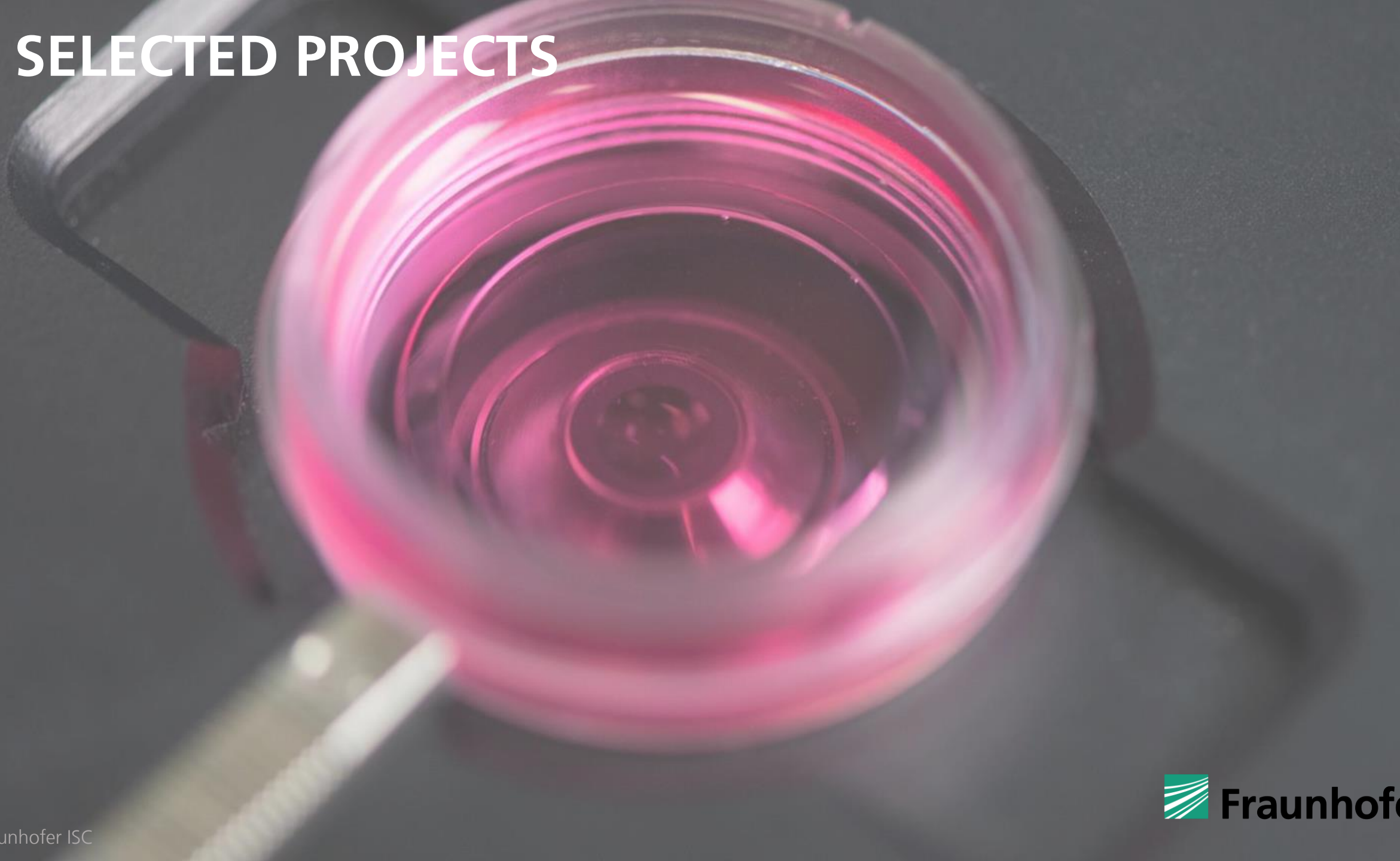
- Magnetorheological fluids
- Magnetorheological elastomers
- Dielectrical elastomer sensors, actuators and generators
- Piezoelectrical thin films and high-temperature ultrasonic transducers
- Silicones

Fraunhofer R&D Center Electromobility

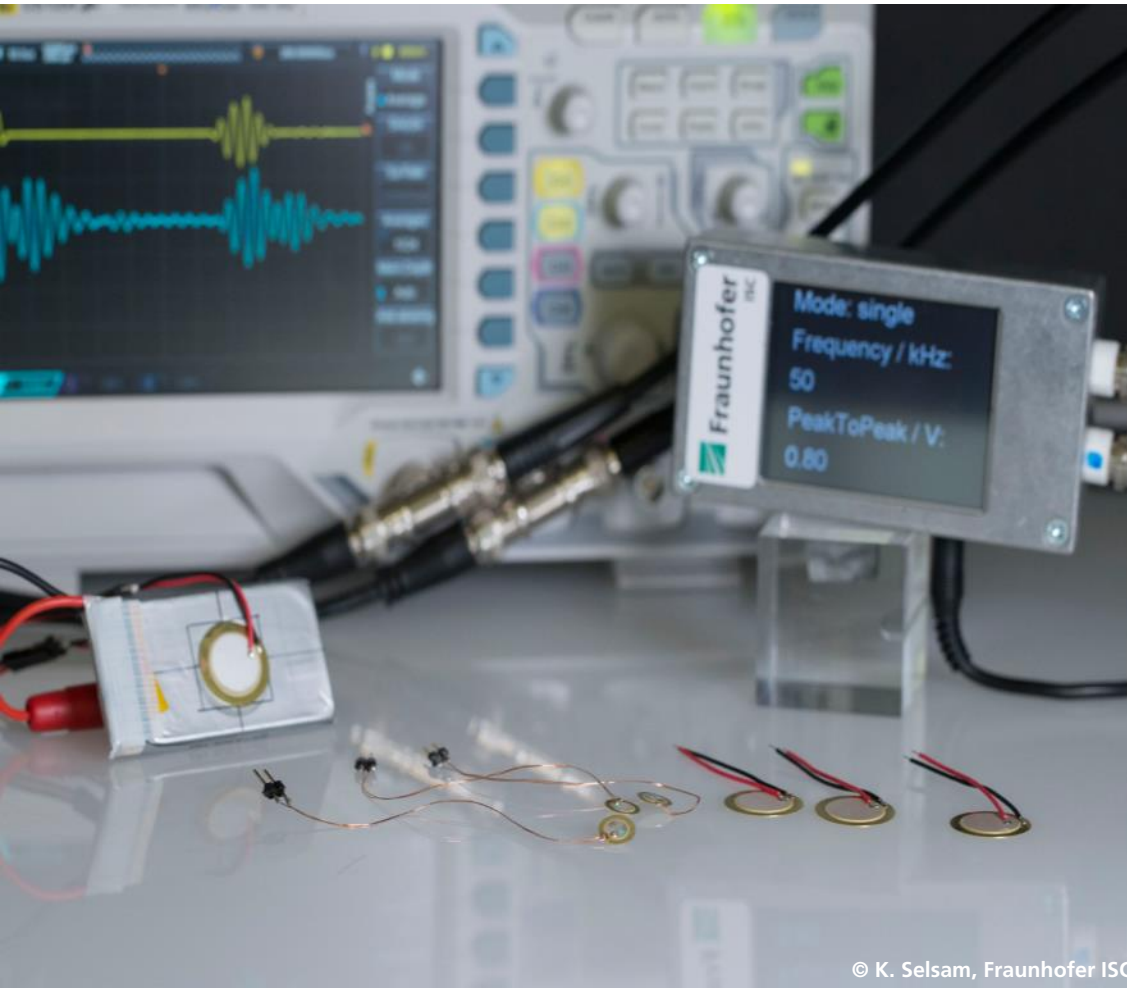


- **Materials and components development for customized battery systems**
- **Customized process development**
- **Electrochromic materials and devices**
- **Analytics, testing and characterization of batteries and components**
- **Battery manufacturing for cell prototypes and small batches**
- **Consulting services**
- **Feasibility studies**
- **International R&D collaborations**

SELECTED PROJECTS



SoCUS – New cost-effective sensor system to measure state of charge



DESCRIPTION

- Funded by the Bavarian Government
- Direct state-of-charge measurement for batteries

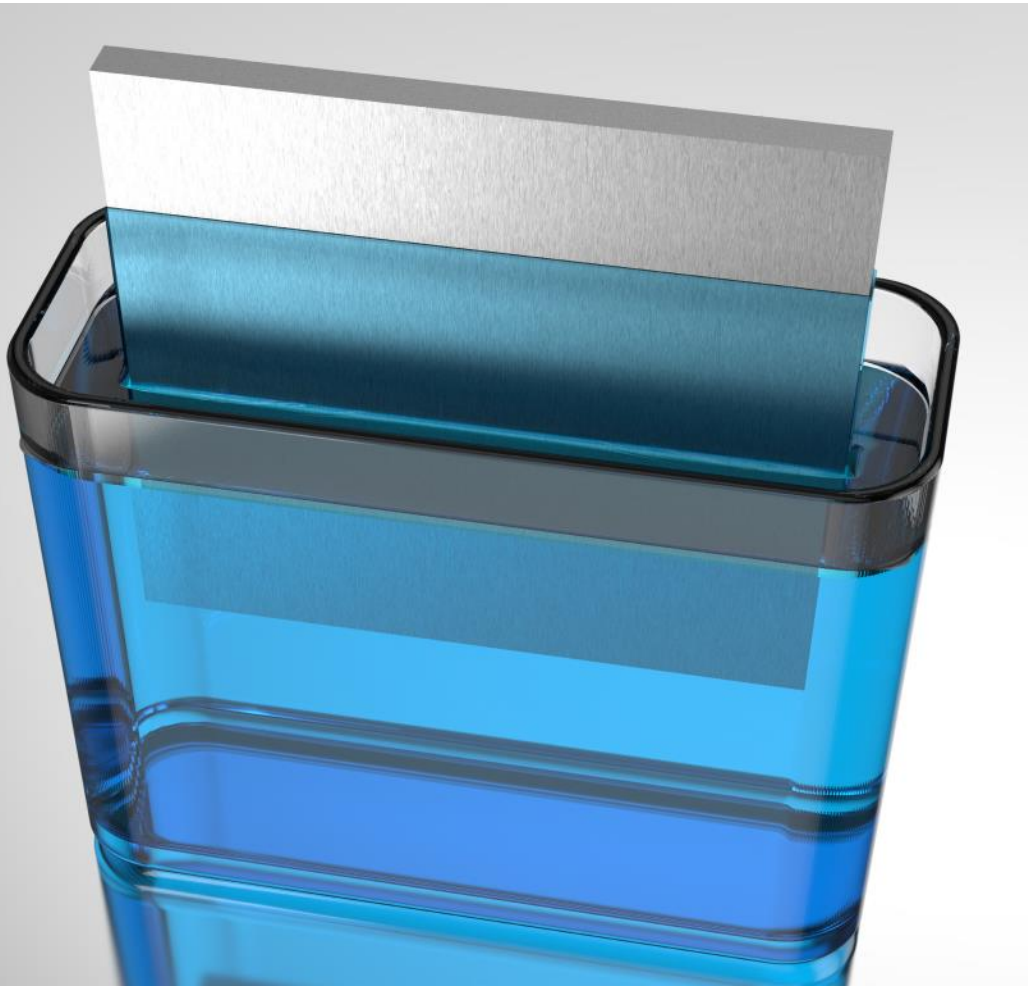
FRAUNHOFER ISC's PART

- Density measurement by ultrasonic pulses
- Fully integrable sensors
- Concept development, proof of concept, testing

BENEFIT

- Battery ageing processes are taken into account
- Reliable state-of-charge monitoring

SOLID – Li-based solid state batteries



DESCRIPTION

- Funded by the Federal Ministry for Education and Research BMBF
- Four industry partners, two Fraunhofer Institutes
- Solid state battery concept for mass production

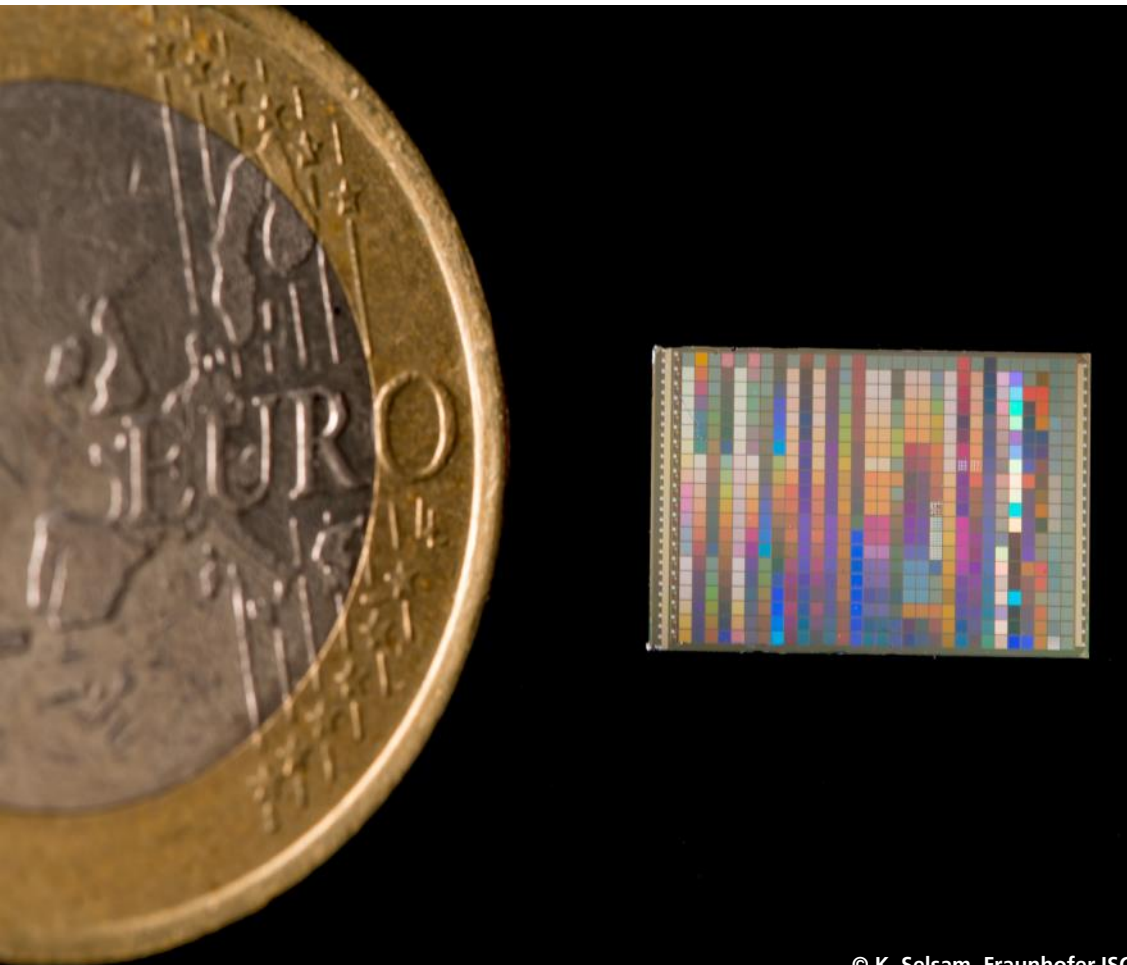
FRAUNHOFER ISC's PART

- Concept, material development
- Cost-efficient and producible R2R processing
- Validation

BENEFIT

- Non-flammable, higher voltage, higher power density

FOWINA – low-cost production of new color sensors



DESCRIPTION

- Fraunhofer initial research
- Extremely compact sensor for color control of displays, LED etc.

FRAUNHOFER ISC's PART

- Flat filter and lens structures via high-precision TPA and nanoimprint patterning,
- Customized material

BENEFIT

- Smaller construction design for ultraflat color sensors
- Higher integration level

Bio4Comp – material design and nanofabrication for biocomputation

DESCRIPTION

- EU project Bio4Comp
- 7 partners
- Basic research

FRAUNHOFER ISC's PART

- Error-free junctions between microfluidic channels via TPA
- Material design and functionalization

BENEFIT

- Parallel processing architecture based on molecular machines
- Lower energy consumption compared to conventional computers



ATFEST – a flexible motor vehicle door check facilitates everyday life



DESCRIPTION

- Funded by the Bavarian Government
- Cooperation with automotive suppliers
- Controlled door opening angles to avoid damage

FRAUNHOFER ISC's PART

- Smart material and component design for adjustable door check via magnetorheological elastomer valves

BENEFIT

- Steplessly adjustable system, controllable via safety sensors

Device development – automated ball testing



DESCRIPTION

- Bilateral cooperation
- Online testing of bearing balls

FRAUNHOFER ISC's PART

- Device development: testing procedure
- Process automation
- Construction

BENEFIT

- Fully automated testing device, integrated in production line, rapid quality control

CoPilot – an open-access platform for particle-based materials



© K. Dobberke, Fraunhofer ISC

DESCRIPTION

- EU project CoPilot, 12 partners
- Minimizing development risks for particle based materials

FRAUNHOFER ISC's PART

- Concept and built-up open-access top-notch pilot line for nanoparticle synthesis (batches up to 1 kg)
- Synthesis control via online analyses for different NP types

BENEFIT

- Reproducible particle properties on a pilot scale
- Easy access for product development and prototyping
- Multiple particle types

NanoFRET – nanoparticles help diagnose malaria: New rapid test in development



DESCRIPTION

- Funded by the German Federal Ministry of Education and Research, 3 partners (started in 2017)
- Early, low-cost and easily accessible malaria diagnosis

FRAUNHOFER ISC's PART

- Particle design and surface functionalization with specific antibodies as analyzing agent
- Detection by time-resolved fluorescence resonance energy transfer (TR-FRET)

BENEFIT

- Highly sensitive and reliable rapid diagnostic tool

BioCHIP – new cartilage for the knee from autologous tissue



DESCRIPTION

- Funded by the EU, 7 partners
- Producing autologous cartilage grafts by tissue engineering

FRAUNHOFER ISC's PART

- Manufacture of clinical trial compounds (cartilage grafts)
- Qualification of manufacturing devices, validation of the manufacturing procedure regarding regulatory aspects (GMP and MDR)

RESULTS

- 14 cartilage grafts successfully implanted since May 2017

Protecting leather – preserving natural haptics



DESCRIPTION

- Several bilateral cooperations
- Protection of leather against aqueous or oily substances and abrasion without harmful substances

FRAUNHOFER ISC's PART

- Design of hybrid polymer lacquers for flexible, natural grown substrates
- Compatibility to further processing steps, barrier functionality

BENEFIT

- High-functional, easy processable lacquers
- Preserving the natural haptics

bioORMOCER®s – eco-friendly packaging solutions



DESCRIPTION

- Several EU projects and initial research
- Advanced bio-based packaging materials to fight plastic-induced pollution

FRAUNHOFER ISC's PART

- Biodegradable barrier coatings for biopolymer films and packaging containers
- Bio-based material synthesis

AWARDED BY ELLEN MAC ARTHUR FOUNDATION

- Materials Challenge 2017 – New Plastics Innovation Prize

Green Vault Dresden – preserving cultural heritage



DESCRIPTION

- Funded by DBU and Fraunhofer
- Long-term restoration materials, stabilizing precious ivory and rock crystal objects within the Green Vault

FRAUNHOFER ISC's PART

- New material formulation and synthesis of hybrid polymers (special needs of restoration: easy handling, infiltration of micro cracks, no alteration, reversibility)
- Validation by accelerated aging and artificial damaging

BENEFIT

- Affordable and reliable restoration material

Modular sorting – from waste material flow to valuable material fractions



DESCRIPTION

- Initial research and development
- Flexible sorting plant

FRAUNHOFER ISC's PART

- Concept and development: multideck screening system
- Sensor-based material and shape sensitive sorting

BENEFIT

- Modular design, flexible alignment
- Removal of toxic waste
- High throughput (several 100 kg/h)

SusCritMat – sustainable management of critical raw materials



© Garry Witthon | Fotolia.de

DESCRIPTION

- EU project funded by KIC EIT Raw Materials, 10 partners
- Knowledge improvement about impact and role of critical raw materials by educational training modules

FRAUNHOFER ISC's PART

- Identification of target group specific surroundings
- Evaluation of knowledge gaps, information needs, favored teaching formats and materials

RESULTS

- Survey covered more than 200 participants from 40 countries; customized educational offers for the classes started in Jan 2018

SIC/SIC-CMC for aircraft gas turbines



© MTU Aero Engines AG

DESCRIPTION

- Funded by the Bavarian Government (three phases in co-operation with suppliers and OEM)
- Production chain for SiC-SiC-based CMC turbine components – concept and process design, pilot manufacture, scale-up into production

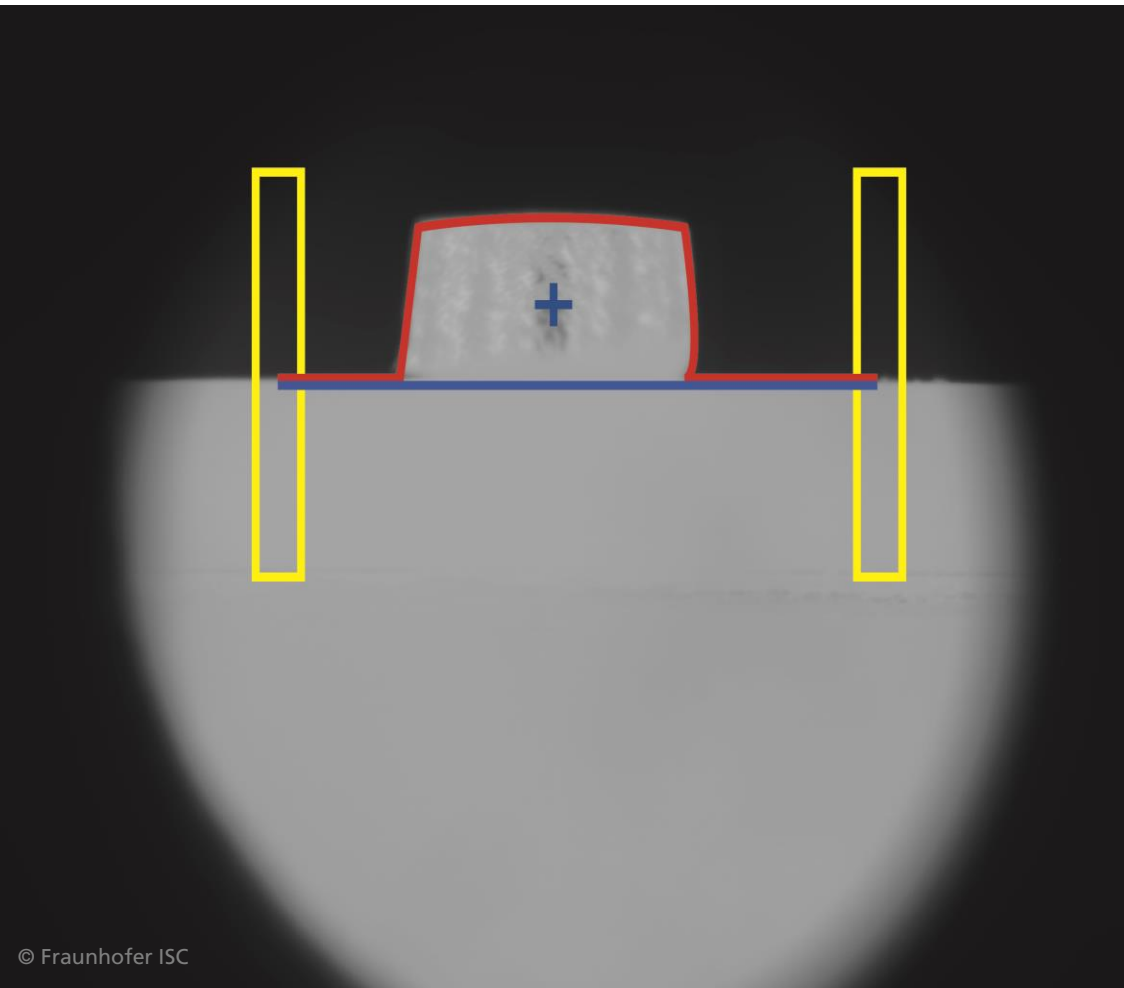
FRAUNHOFER ISC's PART

- Material and component processing concepts
- Pilot manufacture, validation and testing, upscaling

BENEFIT

- Unique technology platform for CMC-components

In-situ measurements during sintering of powder metallurgical components



DESCRIPTION

- Funded by the Bavarian Government
- Optimization of powder metallurgical processing

FRAUNHOFER ISC's PART

- Thermo-optical measurements during sintering
- Evaluation of the effects of thermal and atmospheric conditions during sintering
- Modelling

BENEFIT

- Improved definition and density, improved processing time and energy efficiency

THANK YOU FOR YOUR ATTENTION!



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