Austrian Centre for Electron Microscopy and Nanoanalysis

FELMI-ZFE

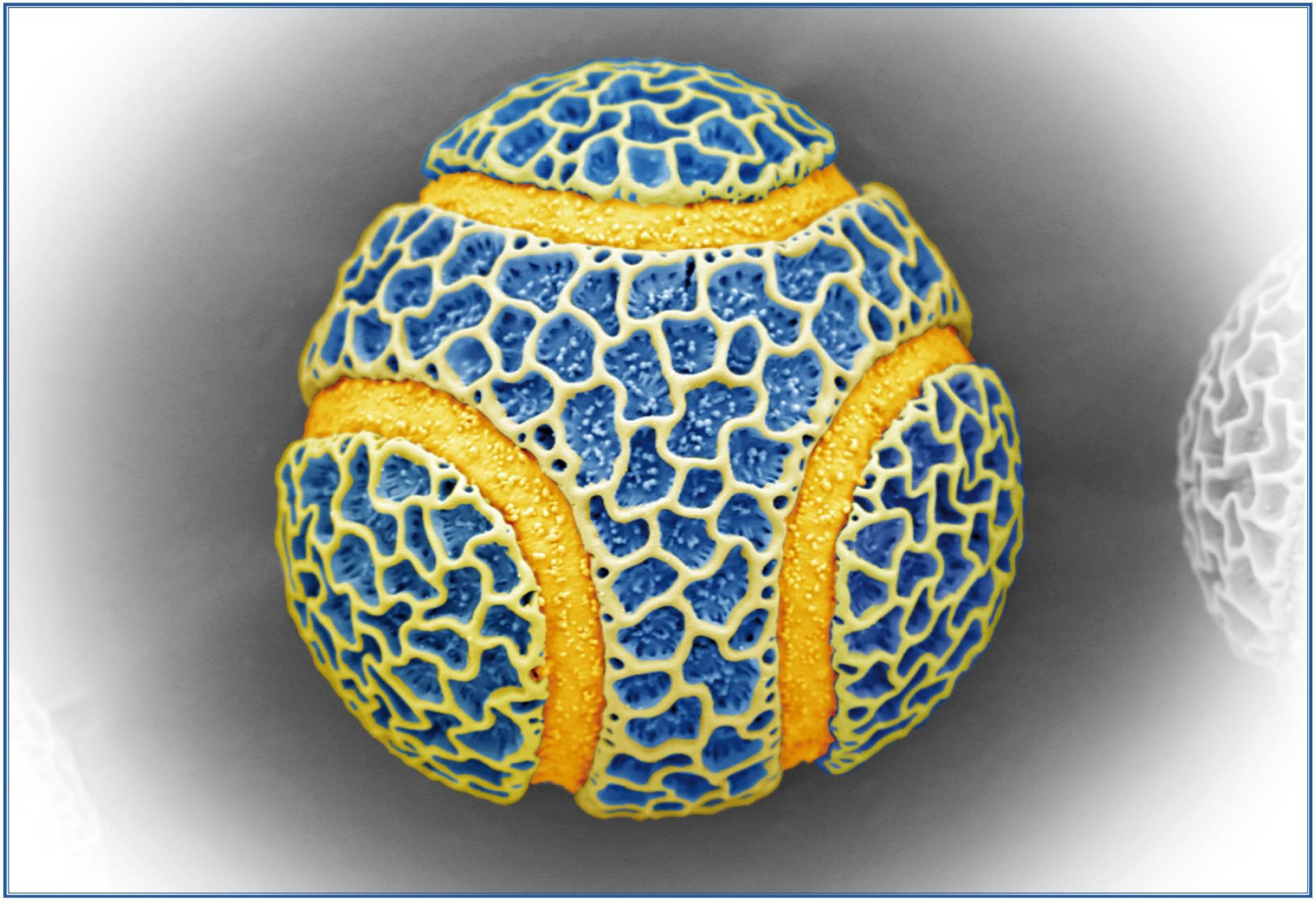
Institut für Elektronenmikroskopie und Nanoanalytik

Zentrum für Elektronenmikroskopie Graz

TU Graz

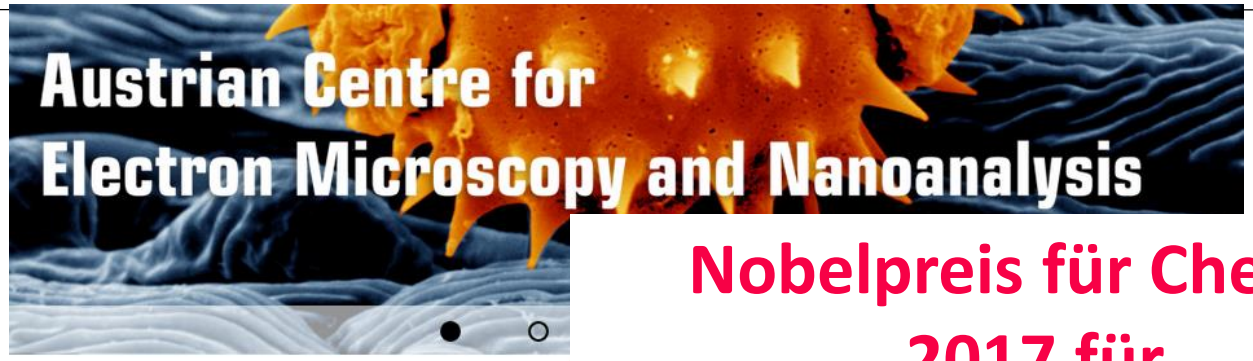
FELMI-ZFE

ACR
AUSTRIAN COOPERATIVE RESEARCH
KOOPERATION MIT KOMPETENZ



Passiflora caerulea (Blaue Passionsblume)

April



Nobelpreis für Chemie 2017 für Kryo-Elektronenmikroskopie

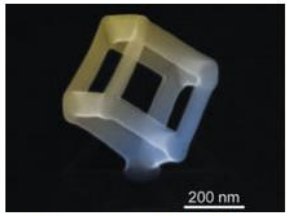
News and Highlights

Professor Helen Chan at FELMI-ZFE
We are very pleased to welcome Helen M. Chan, former chair ...

65 Years Electron Microscopy at Graz
In 1949 an industrial donation of 100,000 Schilling was the ...

Innovation Agent
April 2016 SMEs usually have to face manifold challenges, ...

Congratulations to Jakob Schaller
April 2016 Jakob Schaller started his apprenticeship ...



Publications in High Impact Journals
We are committed to keeping up to date with

Cryo-TEM
Cryo-TEM enables the investigation of aqueous samples ...

ASTEM-Project
The ASTEM is built by FEI Company, Eindhoven, The ...

Video of the Month
Our Expertise Is Your Success

www.felmi-zfe.at

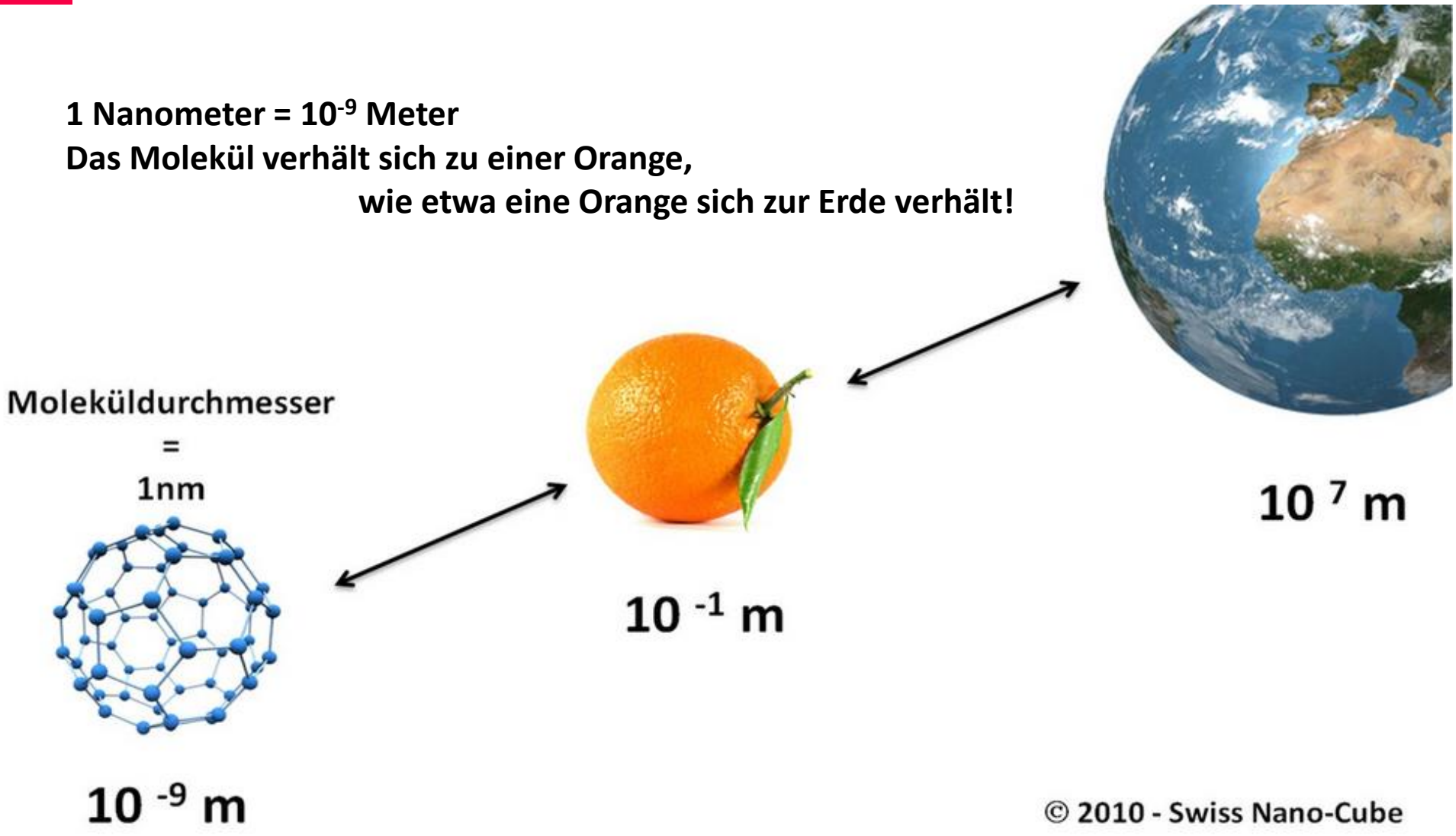
Forschungsthemen

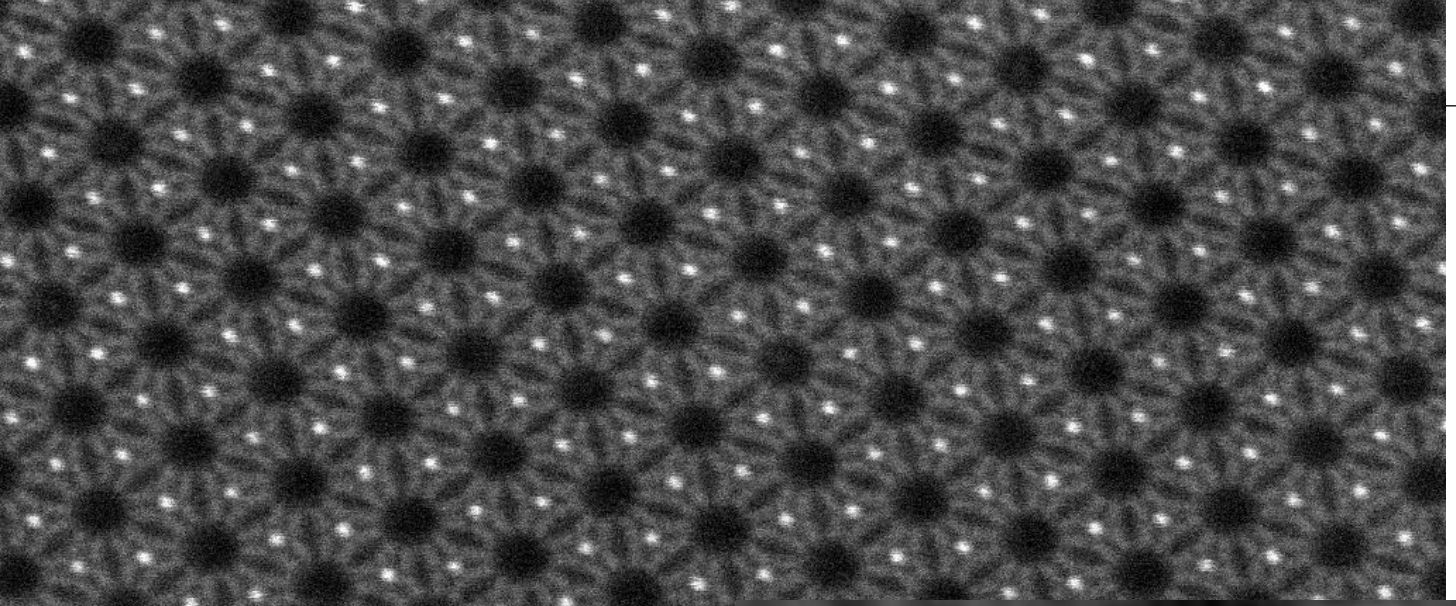
- in-situ Elektronenmikroskopie & korrelative Mikroskopie
- atomar aufgelöste Elektronenmikroskopie von Nanomaterialien
- funktionelle Nanostrukturen
- 3D-Mikroskopie
- Schwingungsmikrospektrometrie

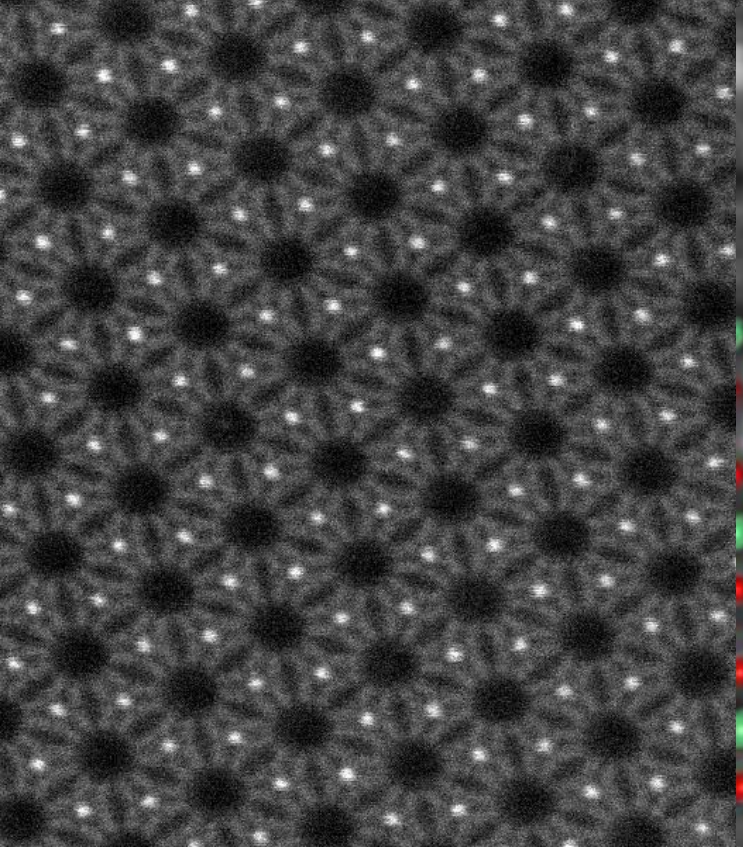
- ~ 55 Personen
- 4 TEMs
- 4 SEMs
- 2 FIBs
- AFM, LiMis, …

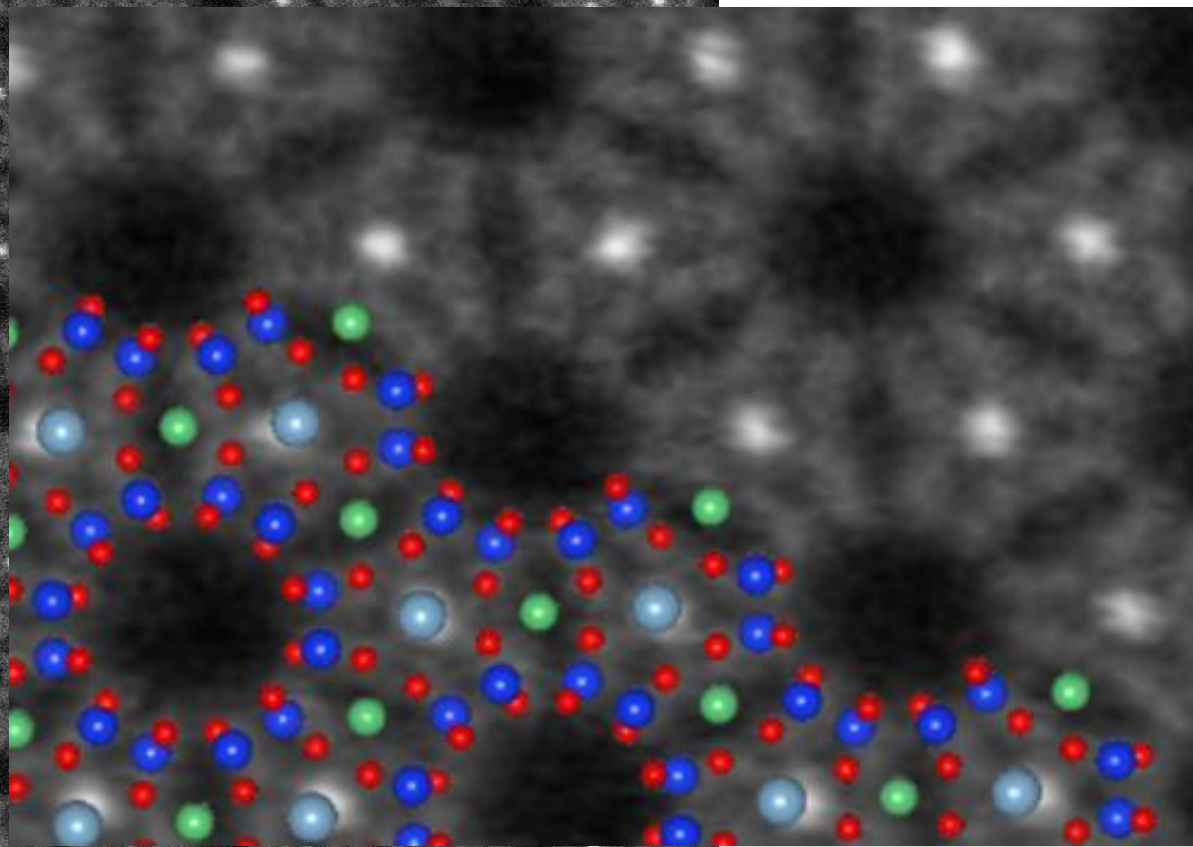
Nanowissenschaften

1 Nanometer = 10^{-9} Meter
Das Molekül verhält sich zu einer Orange,
wie etwa eine Orange sich zur Erde verhält!





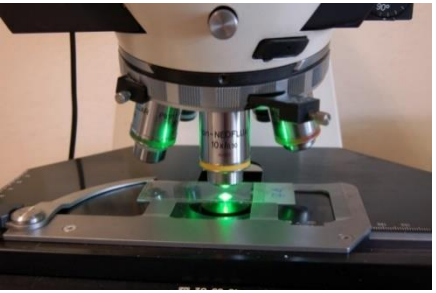


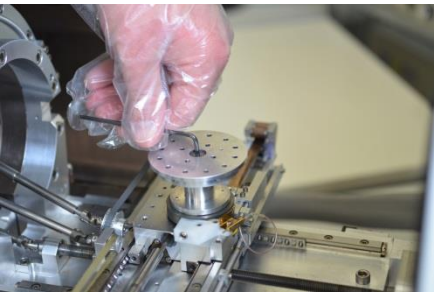


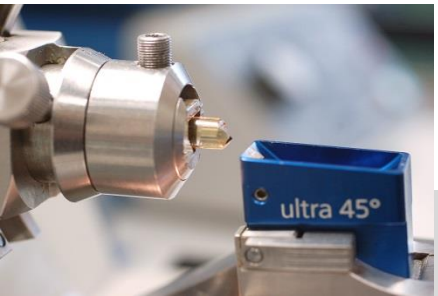
Beryl [0001]

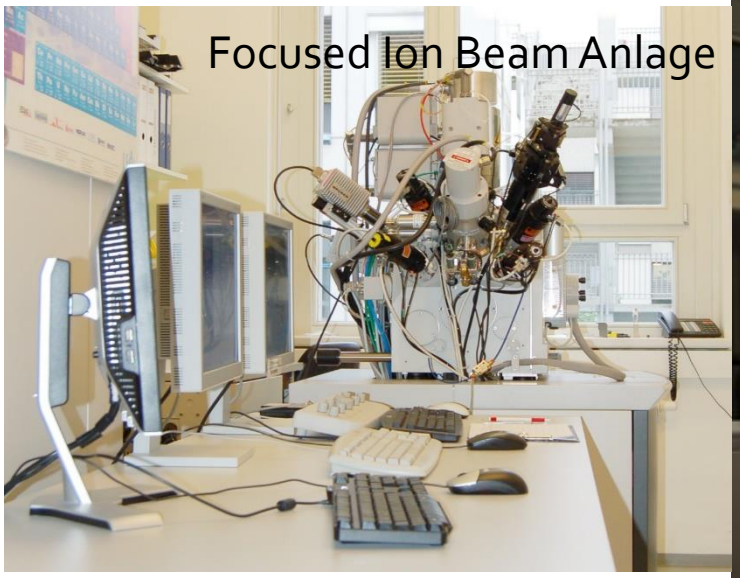
- oxygen
- silicon
- beryllium
- aluminium

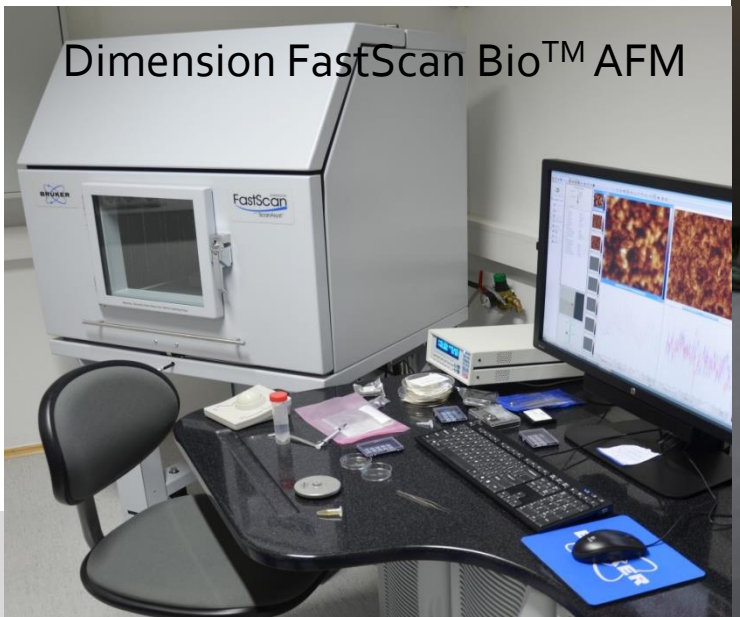
Elektronenmikroskope et al.








Focused Ion Beam Anlage

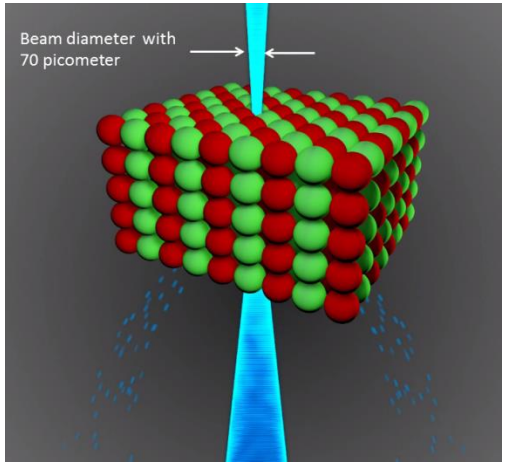

Dimension FastScan Bio™ AFM

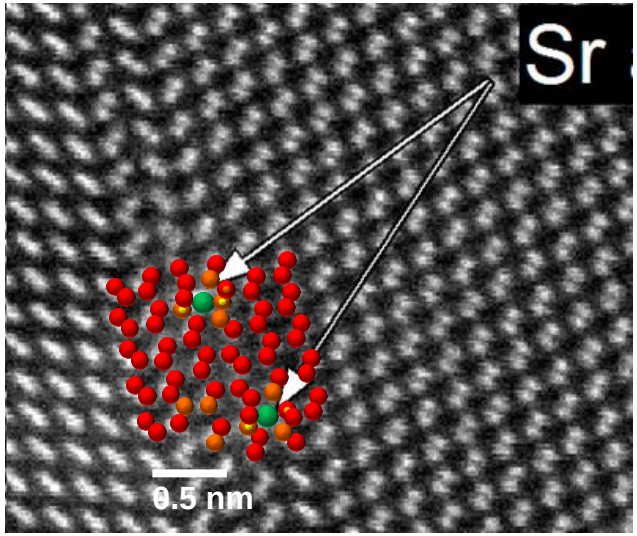
ASTEM FEI Titan³ G2 60-300

Atomic resolution TEM

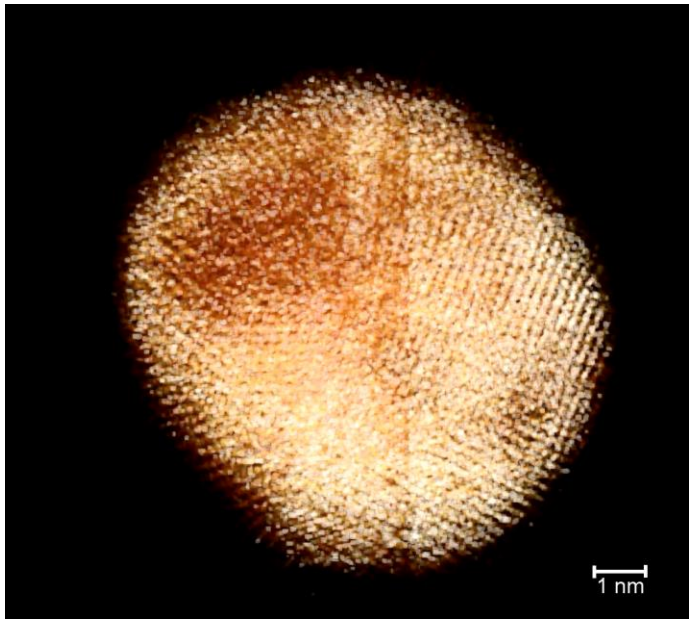
with the Austrian Scanning Transmission Electron Microscope (ASTEM)

HR-STEM imaging resolution > 0.07 nm = 70 picometer

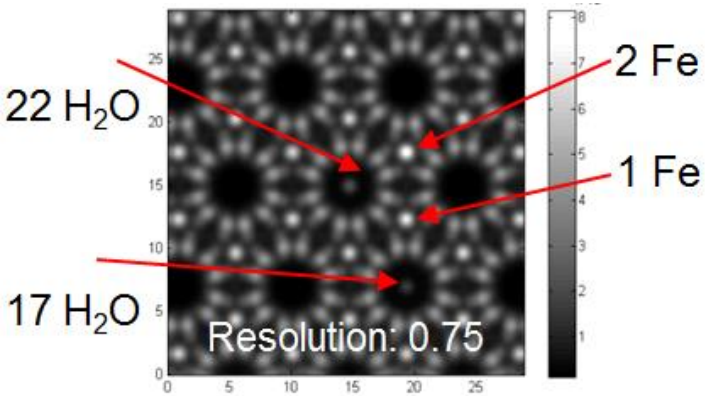




Electron tomography at nanometre & atomic resolution



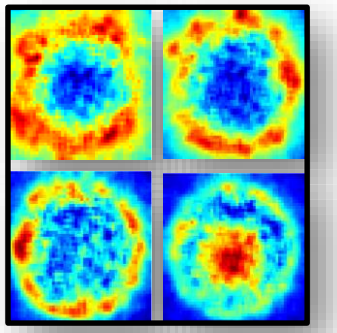
Simulation & modelling



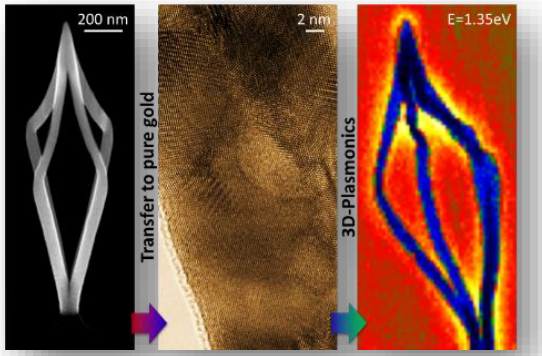
Neue Bauelemente mit 3D Nanodruck

Plasmonic Applications

Planar



Freestanding 3D



Elektrische & magnetische Eigenschaften

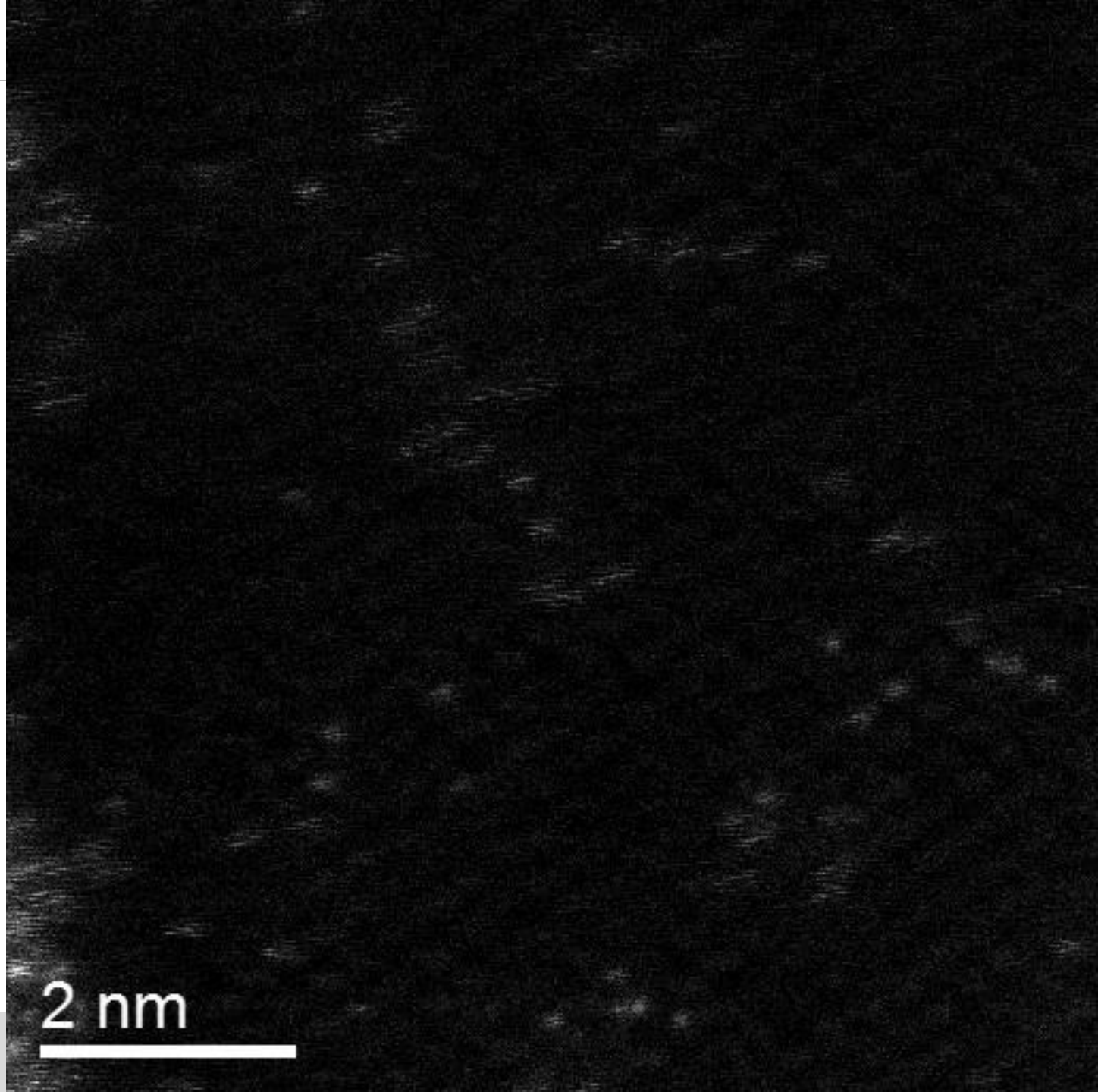
AFM Anwendungen

Christian Doppler Forschungsgesellschaft

Nanocinema

HR-STEM of single atoms

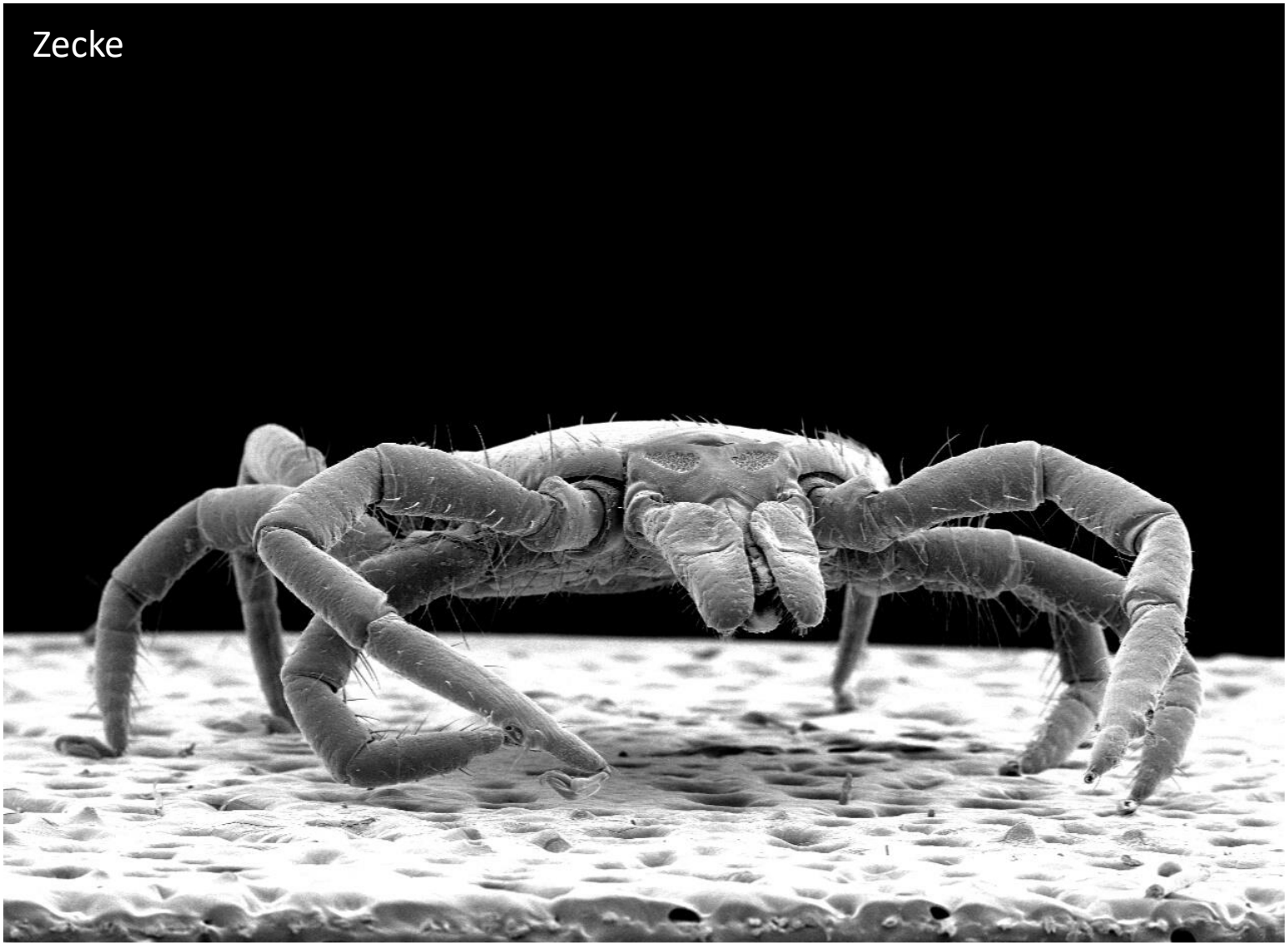
Pt atoms above and below a thin Si crystal



Daniel Knez

Cooperation:
Paul Midgley (U.K.)

Zecke

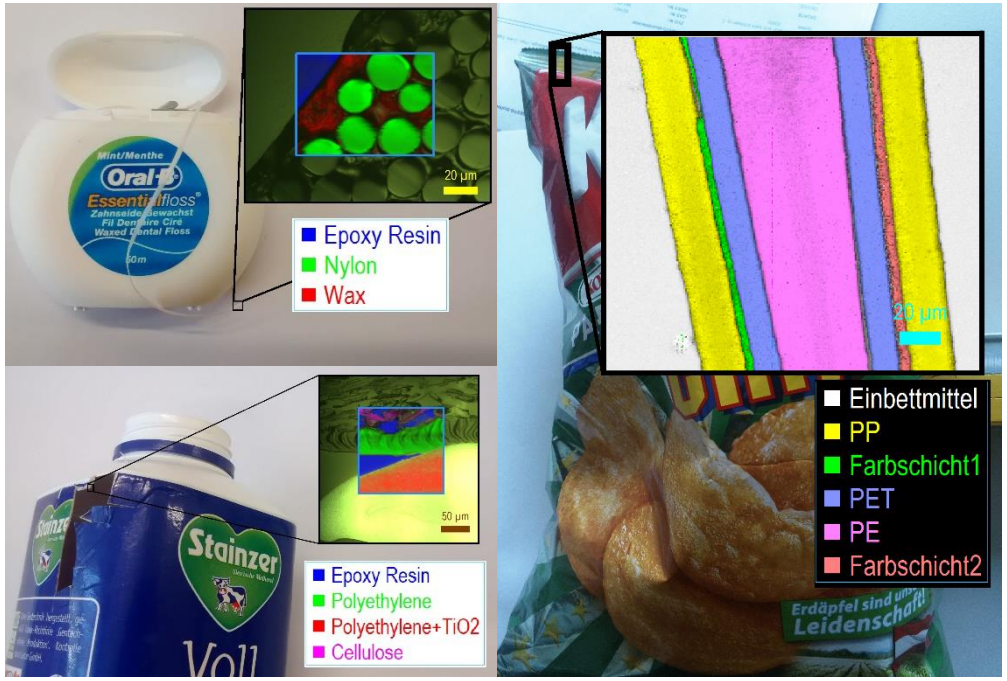


Comparing IR & Raman microscopy

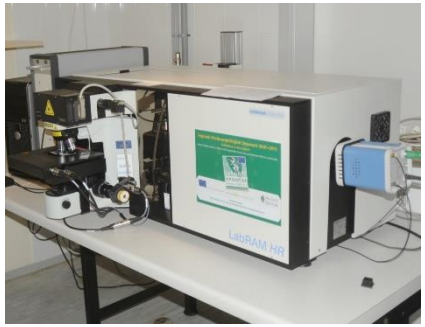
Both IR and Raman microscopy can be used to map the chemical composition on the microscopic level. Some examples of this using everyday items (from an advanced lab exercise) are shown to the right.

The aim of this thesis is to compare the performance of IR microscopy to Raman microscopy. To accomplish this we will take the following steps:

1. Select a couple of suitable samples
2. Prepare the samples for measurement
3. Measure Raman maps & IR maps
4. Evaluate the measurements with regard to both scientific parameters and practical aspects
5. Evaluate to what extend doing both IR & Raman mappings on the same sample might beneficial



Some examples of consumer products that have been measured using Raman microscopy in recent lab exercise



vs.

contact:
Harald Fitzek
Phone: +43 (0) 316 873 8333
E-mail: harald.fitzek@felmi-zfe.at

Kryo-Mikroskopie im ESEM

Die relative Luftfeuchtigkeit im Raum des ESEM - Quanta 600 Raum liegt abhängig von der Jahreszeit bei ung. 60% bis 45% bei 20°C => also zwischen 11 g/m³ und 8 g/m³ H_2O. Leider lässt sich die Höhe der Luftfeuchtigkeit auch durch Verringerung der Raumtemperatur (auf 18°C), durch Reduktion der Frischluftzufuhr und durch die Verwendung eines Luftentfeuchters nicht signifikant reduzieren => 18°C und 43% relative Luftfeuchtigkeit => 6,6 g/m³ H_2O

Dieser relativ hohe Anteil an H_2O führt zu starken Einschränkungen bei der Verwendung des Kryo – Probenhalters[1] (siehe Abbildung 1 -2). Während des Abpumpens in der Probenkammer verdampft der flüssige Stickstoff und die Probe ist für kurzer Zeit zu hoher Luftfeuchtigkeit ausgesetzt => in diesem Moment gefriert Wasser an der Probenoberfläche. Dies ist als Artefakt deutlich bei der Untersuchung von Kryobrüchen zu erkennen (Siehe Abbildung 2).
In der Bachelorarbeit sollen unterschiedliche Methoden ausgetestet werden um diesen Effekt zu verringern bzw. zu unterdrücken:
- Fluten der Probenkammer mit CO_2; - ganzes Mikroskop in einer aufblasbaren GloveBox während der Präparation usw.

Abb. 1: Kryo - Probenhalter

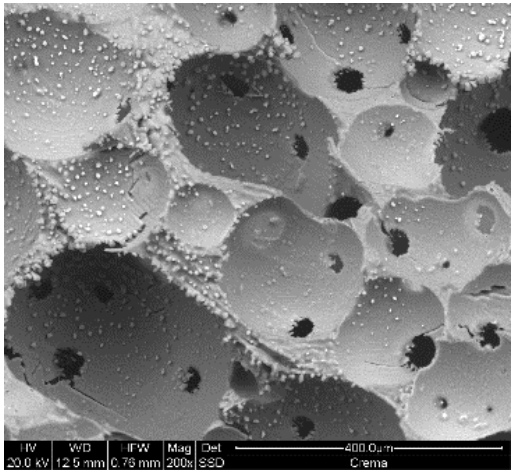
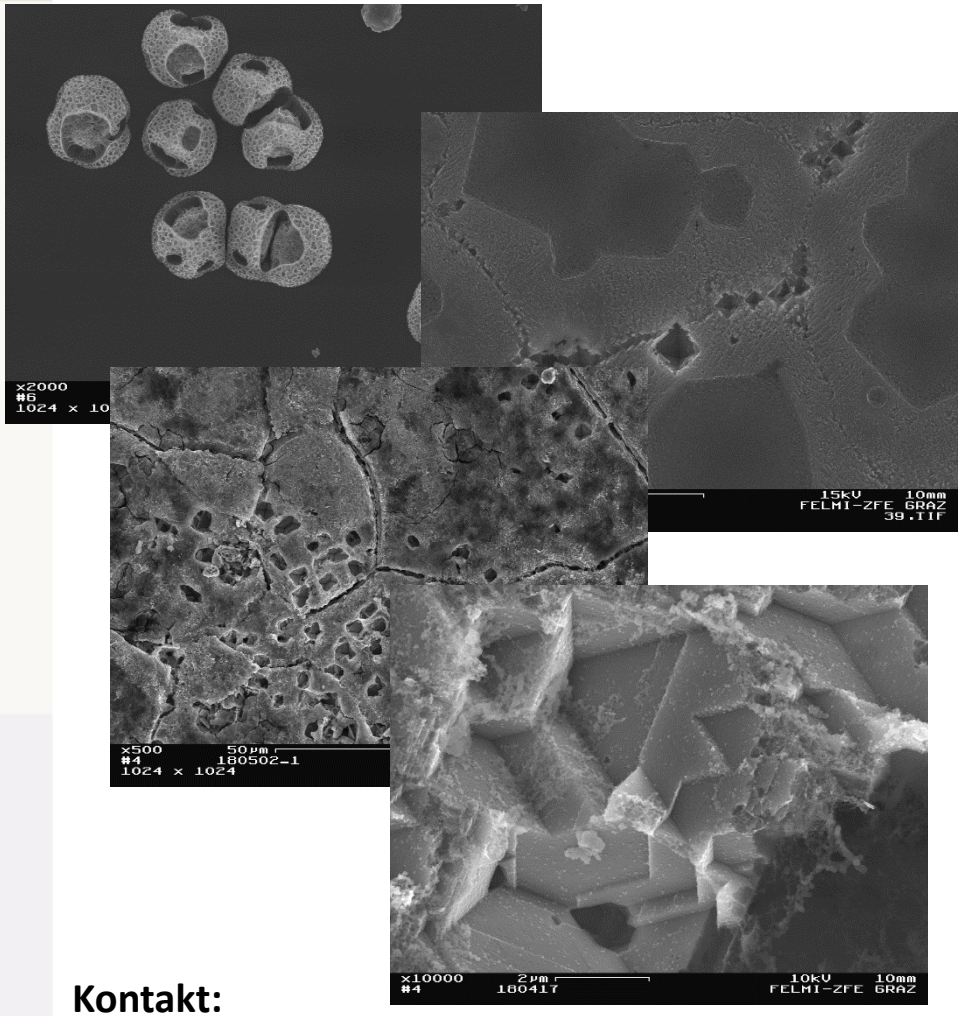


Abb. 2: Kryobruch – Kaffee Crema

Johannes Rattenberger
Tel: +43 316 873 8339
johannes.rattenberger@felmi-zfe.at

1) Chih-Yuan Tang et al., A simple cryo-holder facilitates specimen observation under a conventional scanning electron microscope.Microscopy Research and Technique · 2012

Interessiert an neuartigen Batteriesystemen und Elektronenmikroskopie?



- Im Rahmen des EU Projekts **Salbage** werden in Kooperation mit dem Institut für Chemische Technologie von Materialien (ICTM) **Anoden aus Aluminium(-legierungen)** nach elektrochemischen Versuchen mit Hilfe von **Rasterelektronenmikroskopie** (REM) untersucht.

- Ziel der Arbeit:
  - Erlernen **elektronenmikroskopischer Techniken** und verstehen grundlegender Konzepte
  - **Charakterisierung** von Elektroden Oberflächen mittels **REM**
  - Aufnahme und Auswertung von **EDX**-Spektren

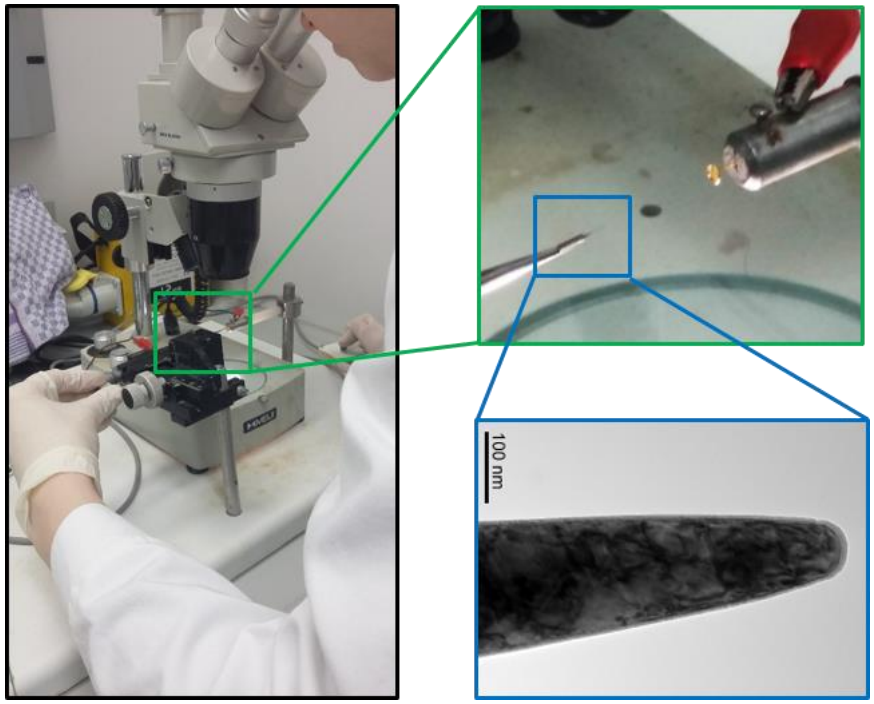
- Es besteht die Möglichkeit **alle vorangehenden Schritte** kennen zu lernen:
  - Vorbereitung der Elektroden
  - Bau der Zelle unter Inertgas (Glove box)
  - Elektrochemische Versuche

Kontakt:

Prof. Gerald Kothleitner

gerald.kothleitner@felmi-zfe.at

Elektronentomographie: Probenvorbereitung mittels Elektropolieren



Elektronentomographie ermöglicht uns einen Einblick in die 3D-Welt von Materialien.

Um diese Materialien untersuchen zu können braucht es eine schnelle und reproduzierbare **Probenvorbereitung**.

Ziel der Arbeit:

- Aufbau einer Elektropolierapparatur
- Finden geeigneter Parameter
- Herstellen von Spitzen für Elektronentomographie mittels Pulsed Electro Chemical Machining
- Überprüfung der Ergebnisse mittels Transmissionselektronenmikroskopie
- Einblicke in die Elektronentomographie

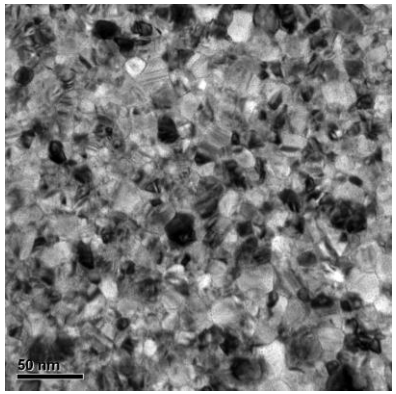
Kontakt:

Prof. Gerald Kothleitner

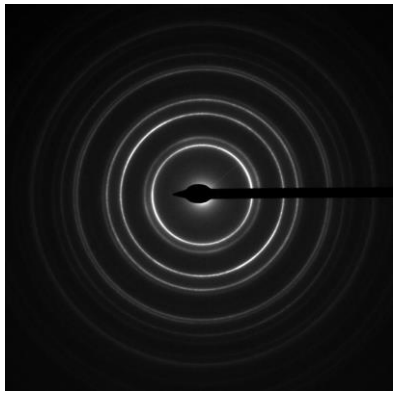
gerald.kothleitner@felmi-zfe.at

Temperature measurements via diffraction patterns in TEM

- Many non-reversible processes in materials must be observed at the nanoscale at elevated temperatures in Transmission Electron Microscopy.
- Resistive four-point probe heaters for TEM have an accuracy of about 95 % - or an uncertainty of more than 50 K above 800°C! There goes your well-defined phase transition…
- **How accurately can you measure temperature contact-free via thermal expansion in TEM?**



polycrystalline sample



diffraction pattern

vary temperature

record diffraction patterns

measure distances

calculate lattice spacing and expansion

compare data with literature

repeat and estimate the uncertainty

What's in it for you?

- Work with pretty expensive equipment in a renowned facility (but still on campus).
- Get a feel for sample preparation and imaging techniques in TEM.
- Use state-of-the-art TEM in situ heating systems.

Courses Micro- and Nanoanalysis, Electron Microscopy, Nanostructures
Laboratory Courses Electron Microscopy, Nanostructuring

Bachelor, Master and PhD students are welcome!