



## Departments Life, Light and Matter

### RESEARCH – LONG TERM – VISION Atomic and Molecular Scale Sensing

#### Molecular Sensing

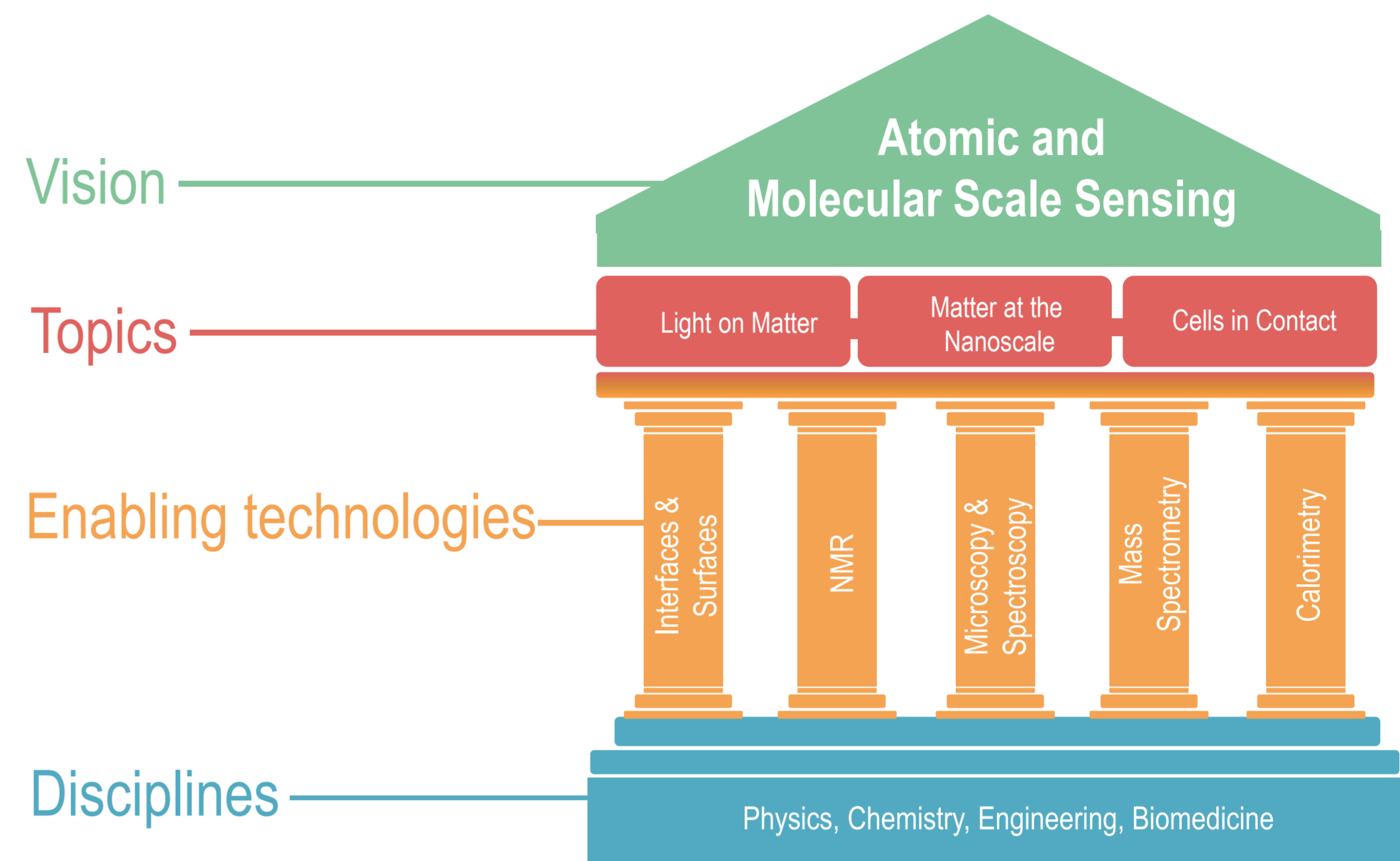
Analyzing and disentangling molecular interactions in ultra-complex mixtures  
Effects, structures and properties of/in complex mixtures; separation of complex mixtures

#### Quantum Sensing

Sensing of nanoobjects such as clusters, nanostructures and biological components  
Biomolecular complexes, imaging of quantum systems  
nanomaterials via NMR, TEM/ EELS

#### Cellular Sensing

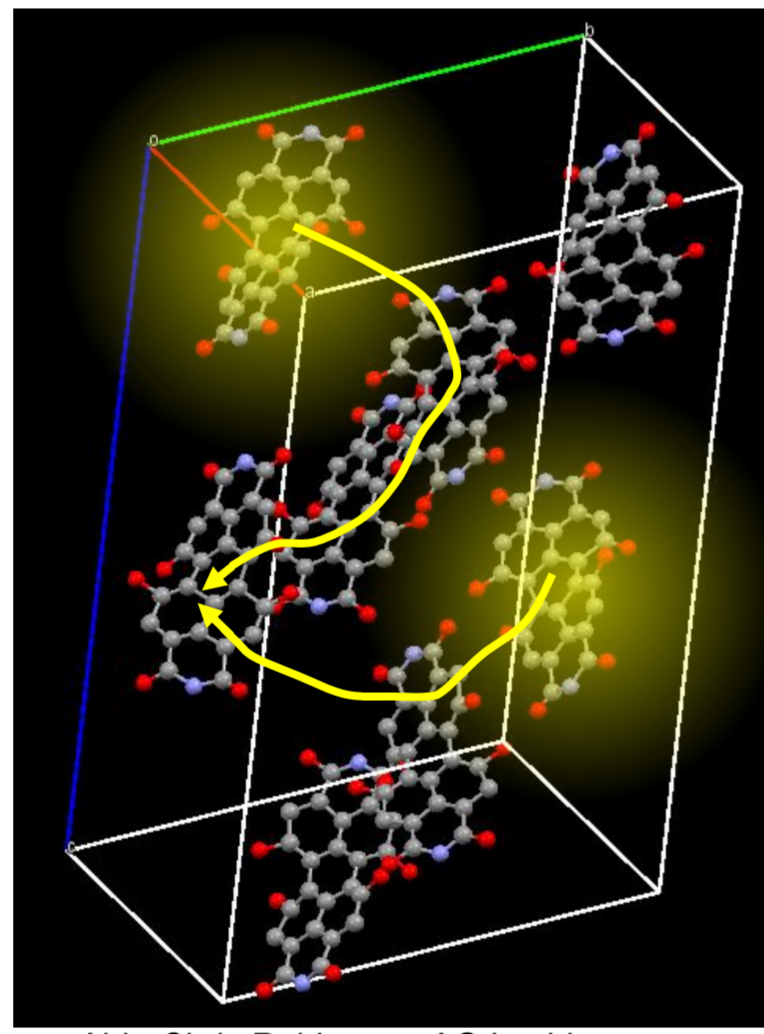
Local cellular response to external stimuli  
Cells as sensors for molecules, nanoobjects and light landscapes



#### Light on Matter

##### Excitons in low dimensional systems

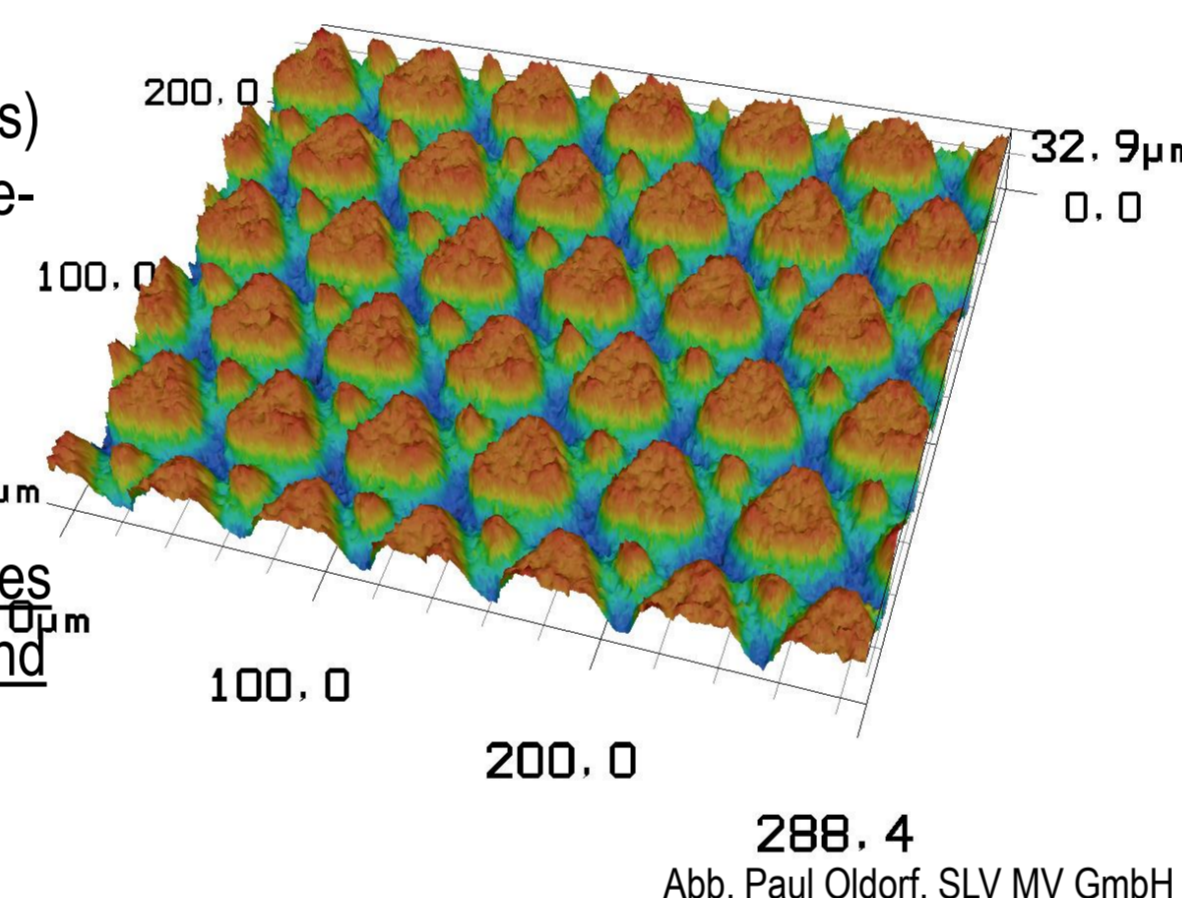
- Guided excitons in nanoparticles-molecule aggregate architectures
- Design of exciton properties using 2D heterostructures and nanoparticles
- Electronic dynamics in molecular layers from high harmonic spectroscopy
- Exciton mobilities and dynamics from time-resolved spectroscopy



#### Matter at the Nanoscale

##### Microstructuring with ultrashort pulses

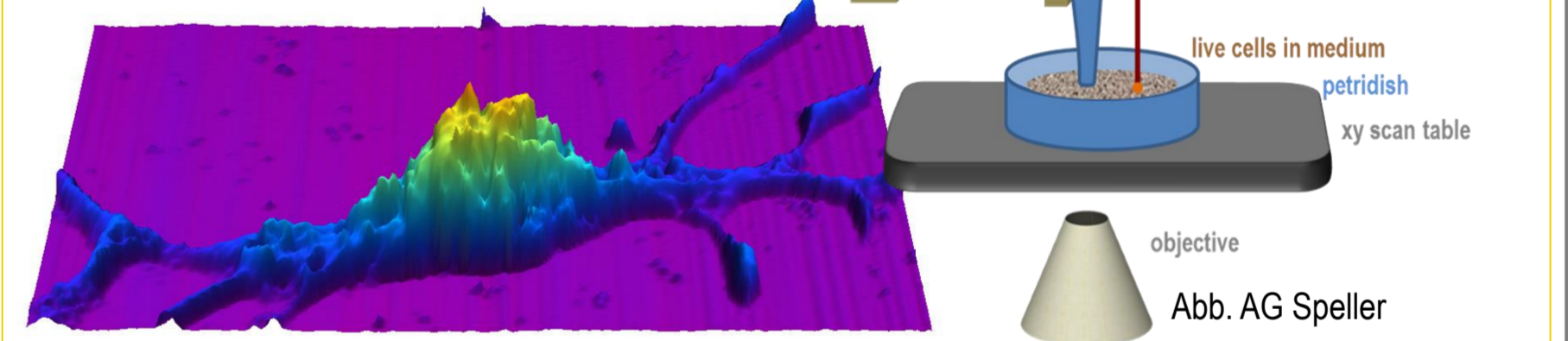
- Machining of thermally sensitive materials (e.g. stents, polymers)
- Ultrashort laser pulse-based surface functionalization of tribological pairing in endoprothetics
- Microscopic processes in laser machining and laser plasmas



#### Cells in Contact

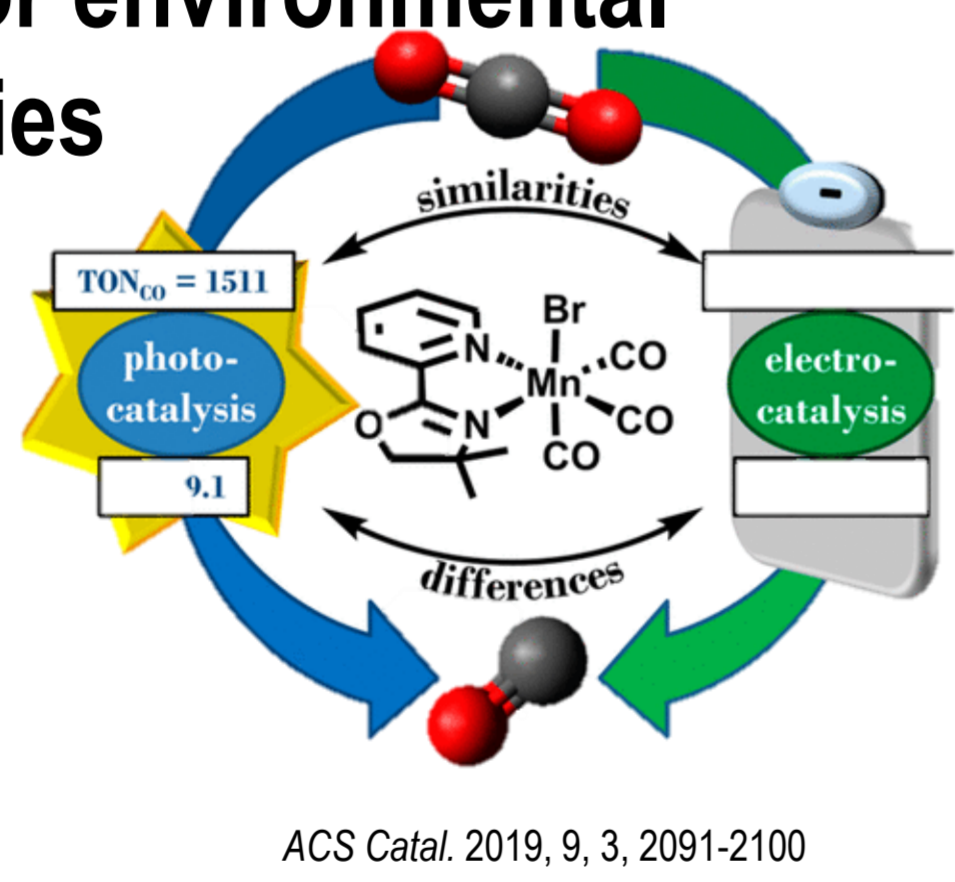
##### Electric and Optical Signals

- Pacemaker cell / tissue for therapy and assessment
- Cardiomyocytes for monitoring and sensing
- Electric and mechanical stimulation for differentiation of cells and tissues
- Photoconversion and optogenetics



##### Photoprocesses for environmental friendly technologies

- Metal complexes as photosensitizers
- Photocatalysis for solar fuels
- Controlling the photoionization of complex molecular systems for mass spectrometry

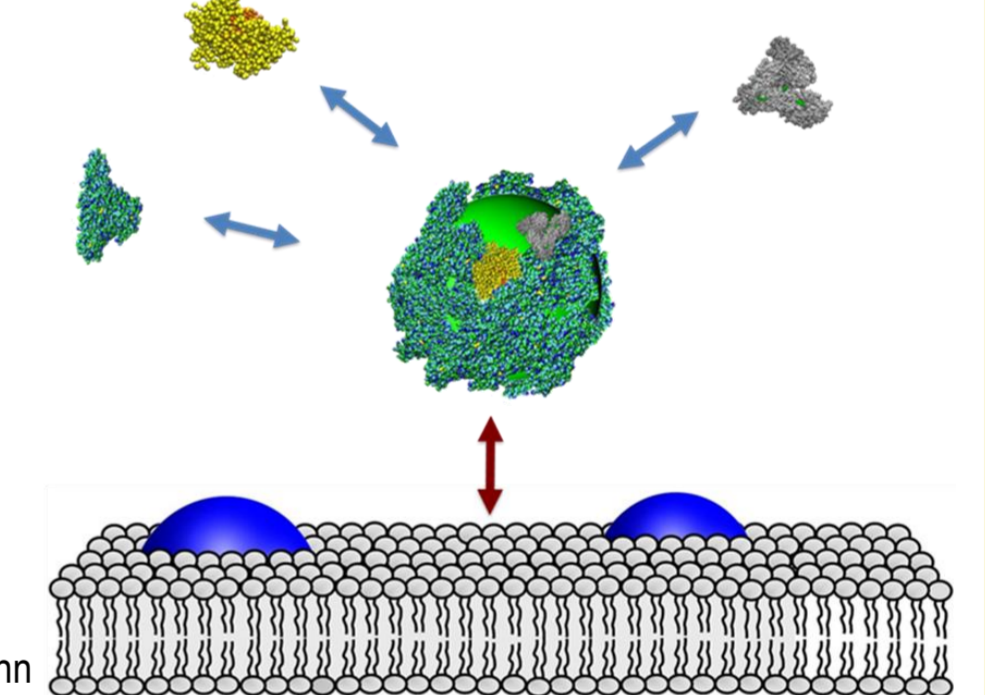


##### Chemically structured surfaces and membranes

- Morphology, composition and toxicity of exhaust particles from combusted marine diesel
- Efficient particle filters and gas scrubbers for marine diesel exhaust gases
- Dispensing technology for filter membrane assembly

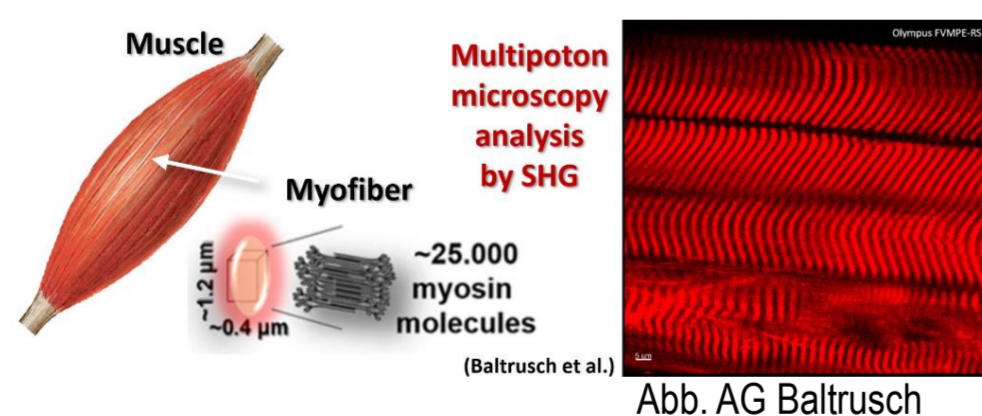
##### Nanoparticles-cell Interaction

- Uptake of nanoparticles in organelles and cells
- Influence of nanoparticles surface and chemistry on cellular reactions
- Cells as sensors for nanoparticles

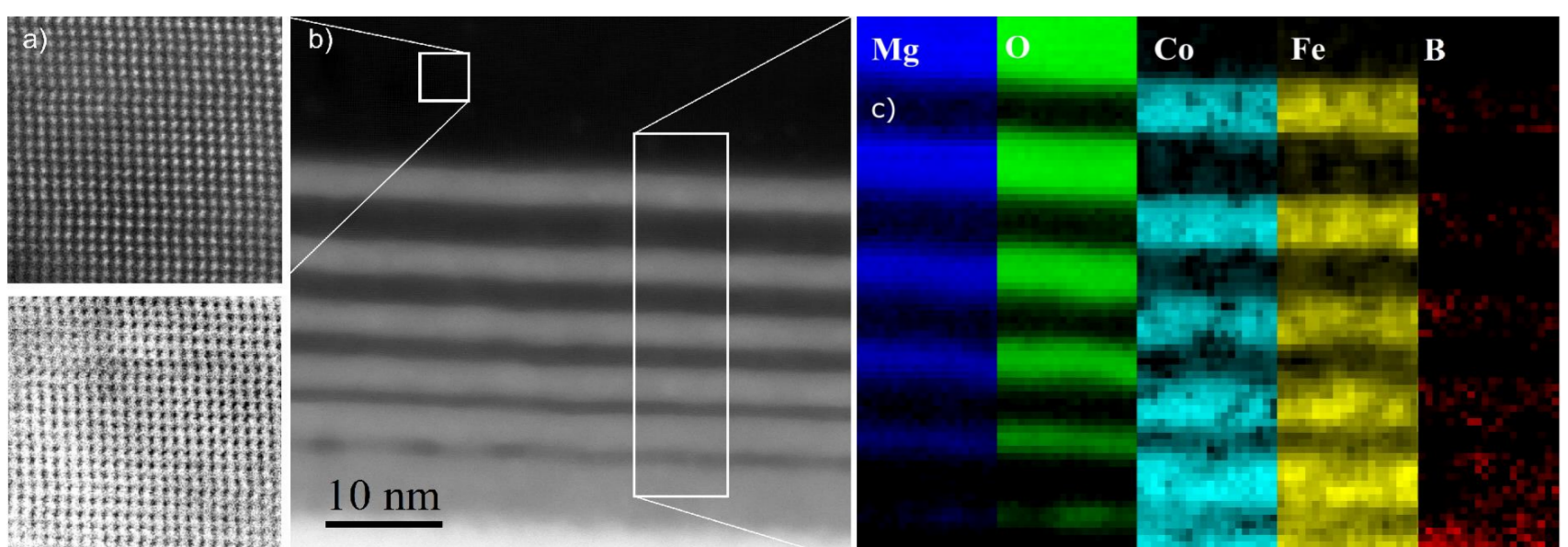


#### Imaging

- Imaging of biological structures by nonlinear optics and Förster energy transfer
- Diffractive imaging and microscopy with high harmonics



- Imaging EELS (electron energy loss spectroscopy) with the new STEM



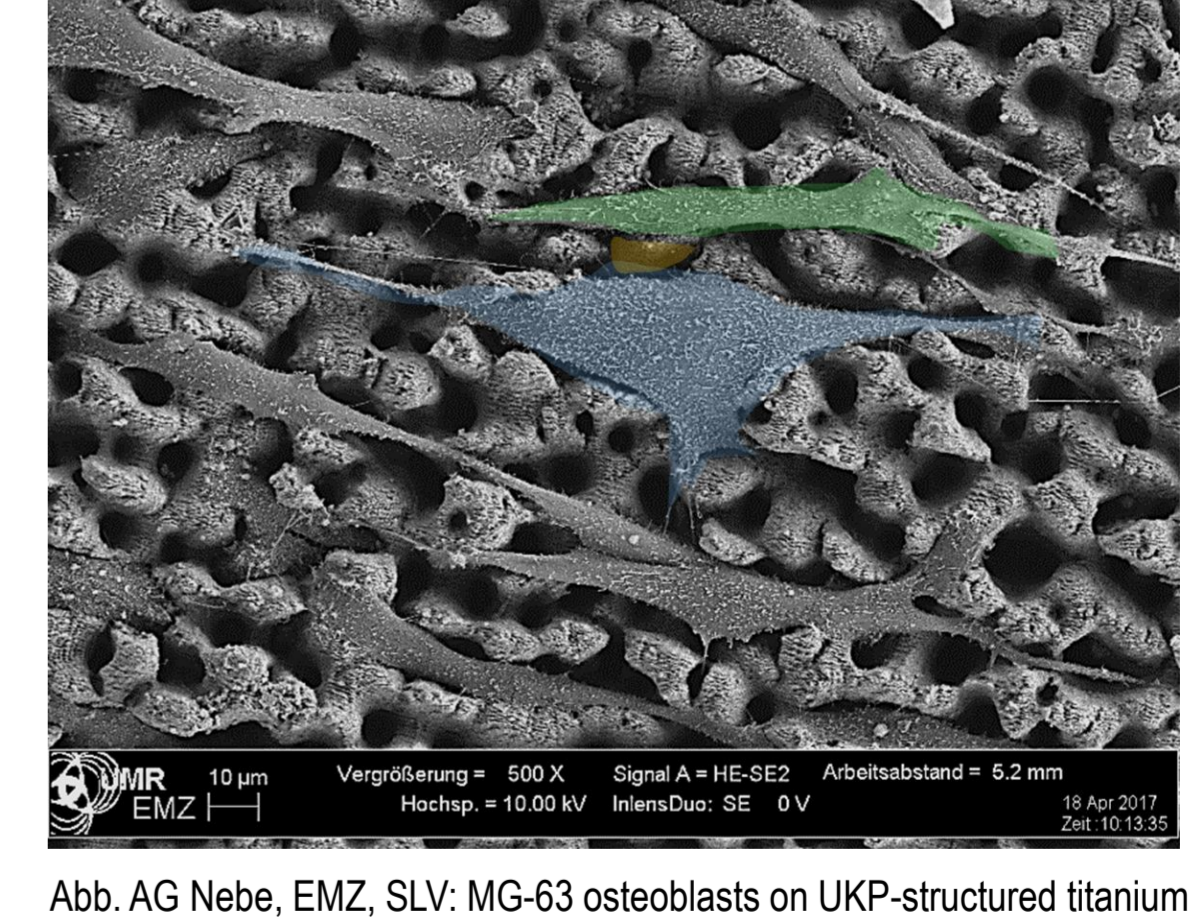
##### Electronic properties of nanostructures

- Functional and chemically protected transition metal cluster films as transistors and sensors
- Low-dimensional optoelectronic materials exploiting quantum effects for new device types



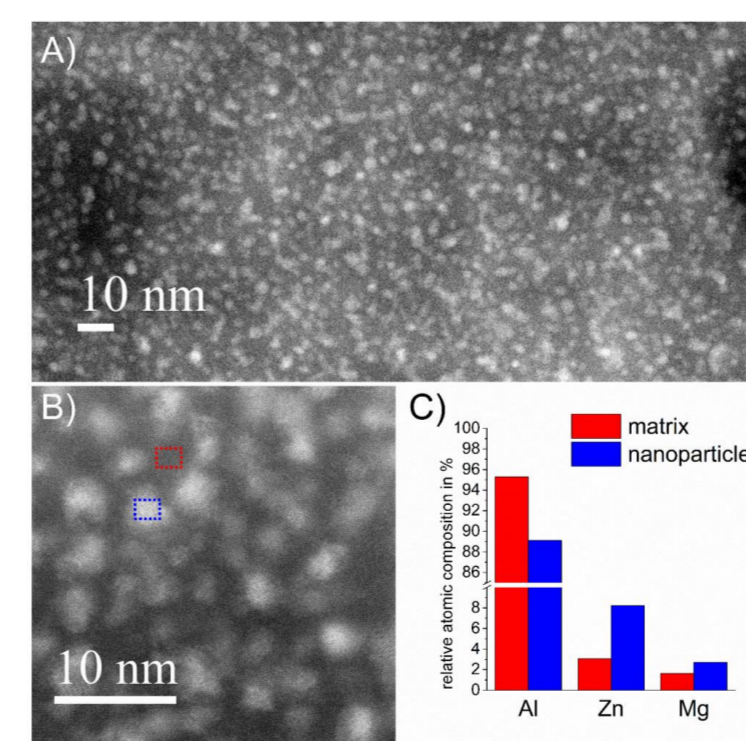
##### Designed Surfaces

- Interaction of cells with structured titanium surfaces
- Drug-delivery systems with drug depots on implant surfaces



##### Nanodesign of bulk materials

- In-situ sensing of phase transformations in materials → designing
- micro-/nano-structures
- Additive manufacturing and design of micro-structures
- Molecular design of renewable fuels



##### Molecular Processes

- Biomolecular recognition by means of dynamic nuclear polarization (DNP)-NMR
- Bio-catalysis
- Mitochondrial activity and dynamics
- Cell-cell contacts and cell adhesion on material surfaces