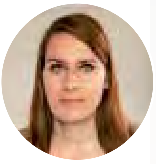

HYBRID NANOSYSTEMS

⟷ Wiebke Albrecht (started in 2021)

We investigate the interaction between different components in complex hybrid nanostructures. For instance, we want to understand the interplay of morphology and underlying charge and energy transfer processes in metal-semiconductor hybrid nanosystems. We furthermore explore new concepts to create hybrid architectures and to locally modify interactions by external stimuli. We also analyze the stability of nanoobjects and explore routes to enhance it. In this way, we hope to make use of synergistic properties in a smart and reliable way, specifically tailored for applications in solar energy harvesting and quantum information processing. Our research combines advanced electron microscopy and single particle optical and time-resolved spectroscopy, for which we constantly develop new techniques and workflows.

Highlights

- Demonstrated that pulsed laser excitation is a powerful tool to engineer the morphology and structure of (plasmonic) nanomaterials [1]. We unravelled the ultrafast dynamics of atomic restructuring in gold nanorods after femtosecond laser excitation [4].

- We built a confocal setup that combines scattering and (time-resolved) luminescence and created a workflow for correlative measurements combining electron microscopy and optical spectroscopy (see Figure). We also highlighted the necessity of performing such correlative measurements [3] and demonstrated new insights into nano-chirality obtained in a correlative manner [2].

- By in situ electron tomography experiments we determined design principle for thermally stable plasmonic nanoheaters [5].

Plans

We want to use optical spectroscopy to determine the morphology of nanoobjects on the nanometer scale with the help of machine learning. We also want to combine optical excitation of nanomaterials and advanced electron microscopy in a new and unique infrastructure at AMOLF. In addition, we will use spectroscopic tools inside the electron microscope to measure the spatial and temporal temperature profiles of catalytically relevant nanoheaters. We will introduce external stimuli like heat and gases inside the transmission electron microscope and our home-built optical microscope to assess the stability of these nanoheaters *in situ*.

Key research items

1. G. González-Rubio, and W. Albrecht, *Engineering of plasmonic gold nanocrystals through pulsed laser irradiation*, Applied Physics Letters 121, 200502 (2022)

2. P. Spaeth, S. Adhikari, W. Heyvaert, X. Zhuo, I. García, L. M. Liz-Marzán, S. Bals, M. Orrit, and W. Albrecht, *Photothermal Circular Dichroism Measurements of Single Chiral Gold Nanoparticles Correlated with Electron Tomography*, ACS Photonics 9, 3995-4004 (2022)

3. M. Dieperink, F. Scalerandi, and W. Albrecht, *Correlating structure, morphology and properties of metal nanostructures by combining single-particle optical spectroscopy and electron microscopy*, Nanoscale 14, 7460-7472 (2022)

4. W. Albrecht, E. Arslan Irmak, T. Altantzis, A. Pedrazo-Tardajos, A. Skorikov, T.-S. Deng, J.E.S. van der Hoeven, A. van Blaaderen, S. Van Aert, and S. Bals, 3D *Atomic-Scale Dynamics of Laser-Light-Induced Restructuring of Nanoparticles Unraveled by Electron Tomography*, Advanced Materials 33, 2100972 (2021)*

5. W. Albrecht, E. Bladt, H. Vanrompay, J.D. Smith, S.E. Skrabalak, and S. Bals, *Thermal Stability of Gold/Palladium Octopods Studied in Situ in 3D: Understanding Design Rules for Thermally Stable Metal Nanoparticles*, ACS Nano 13, 6522-6530 (2019)*

*pre-AMOLF

Combining optical spectroscopy and electron tomography on the same nanoparticle.