CENIDE & WIN Seminar Series on 2D-MATURE

DFG IRTG 2803 & NSERC CREATE

Claudia Backes

University Kassel

"Making nanomaterial inks from insoluble rocks"

September 26th, 2024
10:00 a.m. ET / 16:00 p.m. CET

Claudia is Chair Professor of Physical Chemistry of Nanomaterials at Kassel. She is a chemist by training and has received her Ph.D with honors in 2011 from the University of Erlangen, Germany working under the supervision of Andreas Hirsch. After some time as deputy executive director in the Erlangen Cluster of Excellence "Engineering of Advanced Materials" Claudia received a fellowship grant from the German Research Foundation (DFG) in 2012 and moved to Jonathan Coleman's group at Trinity College Dublin, Ireland. In 2015, she returned to Germany and started her independent research at the Chair of Applied Physical Chemistry at Heidelberg University funded through the prestigious Emmy Noether programme from the German Research Foundation from 2016. In 10/2021, she was appointed to her current position. Claudia's research interests are low dimensional nanomaterials, in particular in liquid exfoliation, nanosheet size control and size-dependent properties, chemical modification and production of composites and hybrid structures.

Liquid exfoliation has become an important production technique to give access to large quantities of two-dimensional nanosheets in colloidal dispersion. Importantly, this is a highly versatile technique that can be applied to numerous layered materials beyond graphene. While this was clear already 10 years ago, some major obstacles on the fundamental level of exfoliation, size selection and characterisation had to be overcome. In this talk, I will review the most important steps that allowed us to arrive at a point, where it is possible to produce samples suitable for (device) applications. This will include the following aspects:

- Elaborating reliable deposition and analysis protocols to quantify lateral size and layer number by AFM
- Size selection through centrifugation using band sedimentation and liquid cascade centrifugation including a novel quantitative description with an equation of motion accounting for dimensionality
- Crucial insights in the exfoliation mechanism that is based on simultaneous nanosheet delamination and tearing with an equipartition of energy
- The realisation that size and thickness information is encoded in optical absorption and extinction spectra that allows to derive metrics for nanosheet size through a correlation with microscopy statistics
- Exfoliation under inert gas which enables the analysis of degradation kinetics and thermodynamics (i.e. activation energy) revealing that many types of nanosheets are less stable in ambient conditions than expected
- Controlled deposition into tiled networks of well-aligned nanosheets with dense coverage
- Strategies for achieving basal plane and edge functionalisation of transition metal dichalcogenide nanosheets in the liquid phase