

Dienstag, 23.02.2016**Hörsaal D, Chemiezentralgebäude, 17:15 Uhr****Sprecher: Claudia Backes**
*(Universität Heidelberg)***Titel: Liquid-exfoliated inorganic 2D-materials:
Production, characterisation and
functionalisation****Abstract:**

Two dimensional nanomaterials beyond graphene such as transition metal dichalcogenides (TMDs) or black phosphorus (BP) have received considerable attention the past years because of their interesting physical properties and applications potential in a number of areas. In order for these materials to be used, large quantities of controlled sizes need to be made available. Even though exfoliation in suitable liquids is an important production technique, the polydispersity in terms of size and thickness is currently a bottleneck and difficult to control. This is mostly because size and thickness measurements by statistical microscopy are tedious and time consuming and no techniques to easily measure nanosheet sizes, thicknesses and monolayer content are available. This is a significant hurdle for both fundamental studies and the use of the liquid exfoliated materials in applications. In addition, methods to fine-tune physical properties by functionalisation are currently scarce.

In my talk, I will address these issues and review recent progress on producing various liquid-exfoliated 2D nanosheets including GaS¹ and black phosphorus² and their functionalisation.^{3,4,5} In addition, I will show that nanosheets size, thickness and monolayer content can be quantitatively determined from optical spectroscopy. For example, mean number of layers and lateral dimensions of liquid exfoliated TMDs can simultaneously be obtained from an optical extinction spectrum due to edge and confinement effects.⁶ We have now developed further metrics based on the measurement of the Raman and photoluminescence in liquids to quantitatively determine the monolayer (ML) content in TMD dispersions.⁷ This laid the foundation to design cascades of centrifugation steps to maximise the ML volume fractions. Up to 75 % ML content can readily be achieved. Such samples are ideal to study fundamental optical properties such as absorbance and photoluminescence of nanosheets dispersion with varying size distributions. In addition, the optical measurements confirm the high structural quality of the liquid exfoliated nanosheets.

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[2] Hanlon, D.; Backes, C.;... Coleman, J. N., "Liquid exfoliation of solvent-stabilised black phosphorus: applications beyond electronics" *Nature Commun.* **2015**, 6, 8563.

- [3] Backes, C., Berner, N.; McDonald, A., "Functionalization of liquid-exfoliated two-dimensional 2H-MoS₂", *Angew. Chem. Int. Ed.* **2015**, 54, 2638-2642.
- [4] Knirsch, K.; Berner, N.; Backes, C., "Basal-plane functionalisation of chemically-exfoliated molybdenum disulfide by diazonium salts", *ACS Nano* **2015**, 9, 6018-6030.
- [5] Vega-Mayoral, V.; Backes, C.; Coleman, J. N., "Monolayer photoluminescence of liquid-exfoliated WS₂ in poly (vinyl alcohol) polymer composites." *Adv. Func. Mater.* **2015**, in press.
- [6] Backes, C.; Smith, R. J.; McEvoy, N.; ... Coleman, J. N., "Edge and Confinement Effects Allow in situ Measurement of Size and Thickness of Liquid-Exfoliated Nanosheets" *Nature Commun.* **2014**, 5, 4576.
- [7] Backes, C.; ... Coleman, J. N., "Production of Highly Monolayer Enriched Dispersions of Liquid-Exfoliated Nanosheets by Liquid Cascade Centrifugation", *ACS Nano* **2015**, in review.

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