

Covalent functionalization of photoluminescent liquid-exfoliated WS₂ nanosheets

Tim Nowack, Steffen Ott, Claudia Backes

Institute of Physical Chemistry, University of Heidelberg, D-69120 Heidelberg, Germany

Tim.Nowack@pci.uni-heidelberg.de

Abstract

Transition metal dichalcogenides (TMDs), such as WS₂, turn from indirect into direct semiconductors when exfoliated to monolayer thickness. For applications in (opto) electronics, enhancement of the intrinsically low photoluminescence quantum yield of TMD nanosheets would be required. One potential approach to tackle this task, is the introduction of new types of defects to the nanosheet surface, which might allow for localized emission. In this project the covalent aryl functionalization of WS₂ nanosheets and effects upon optical properties were investigated.

Liquid-exfoliated WS₂ nanosheets in water/surfactant dispersions were size selected, according to literature known centrifugation protocols.^[1] Dispersions with high monolayer content, were treated with aryl diazonium salts in different concentrations to achieve functionalization. By performing solvent transfer to IPA, colloidal stable dispersions of WS₂ nanosheets were obtained, which were used for further film fabrication. Extinction, Raman and photoluminescence spectroscopy suggest reduced nanosheet aggregation due to functionalization. In thin films spectral features typical of individual TMD monolayers, such as A exciton PL, are largely maintained. A potential correlation between the observed Raman modes and surface coverage with aryl moieties is discussed. Characterization of films, assembled at liquid-liquid interfaces, suggests that functionalization leads to improved high film homogeneities and increased hydrophobicity of surfaces.

References

- [1] Claudia Backes, Beata M. Szydłowska, Andrew Harvey, Shengjun Yuan, Victor Vega-Mayoral, Ben R. Davies, Pei-liang Zhao, Damien Hanlon, Elton J. G. Santos, Mikhail I. Katsnelson, Werner J. Blau, Christoph Gadermaier, and Jonathan N. Coleman, *ACS Nano*, **10** (2016) 1589-1601.