Hybrid Inorganic/Organic Systems for Opto-Electronics

Collaborative Research Centre 951

Colloquium Announcement

of the Collaborative Research Centre 951
"Hybrid Inorganic/Organic Systems for Opto-Electronics"

Alexander Holleitner

Walter Schottky Institute and Department of Physics,
Technical University of Munich, Germany

Precisely positioned atomistic quantum emitters in monolayer MoS_2

Stefan Hecht

Leibniz Institute for Interactive Materials, Aachen, Germany;
Institute for Technical and Macromolecular Chemistry, RWTH Aachen, Germany;
Department of Chemistry and IRIS Adlershof, Humboldt-Universität zu Berlin, Germany

Xolography for volumetric 3D printing

Time: Thursday, 16.12.2021, 15:15

Place: The colloquium takes place online (ZOOM)

Meeting-ID: 615 2251 9123
Password: 209487

Collaborative Research Centre 951
Department of Physics
Humboldt-Universität zu Berlin

Email: sfb951@physik.hu-berlin.de
Tel.: +49 30 2093 66374
www.physik.hu-berlin.de/sfb951

Partners

Precisely positioned atomistic quantum emitters in monolayer MoS_2

Alexander W. Holleitner

Walter Schottky Institut and Physics Department, TU Munich, Germany

In this talk, I will demonstrate the deterministic generation of single defects acting as quantum emitters in monolayer MoS_2 van der Waals heterostructures. The emitters are naturally confined to the few atoms limit axially while having a lateral creation accuracy of ~9 nm generated by highly local helium ion irradiation only limited by secondary ion events [1-3]. We reach defect creation efficiencies close to unity in larger irradiated spots and as high as 18% for single shot irradiation. The optical line shape reveals a strong asymmetry resembling the interaction with LA/TA phonons. Employing the independent Boson model to our emission lines, we find that the emitters are spatially localized to a length scale of 2 nm, which is consistent with cryogenic scanning tunneling microscopy (STM) on the samples [3-5]. I will also discuss the level structure, the magnetic properties, and the absorption characteristics of the emitters.

The demonstrated methodology allows positioning single photon emitters with a precision of only a few nanometers in large arrays of quantum emitters [6] and in already stacked heterostructures with electrostatic gates [7]. Our work paves the way towards the controlled and deterministic generation of quantum emitters in monolayer transition metal dichalcogenides (TMDCs) van der Waals heterostructures as well as photonic, optoelectronic, and plasmonic quantum devices.

References:

(1) J. Klein et al., Site-selectively generated photon emitters in monolayer MoS_2 via local helium ion irradiation. Nature Comm. 10, 2755 (2019).

(2) J. Klein et al. Robust valley polarization of helium ion modified atomically thin MoS_2, 2D Materials *5*, 11007 (2018).

(3) E. Mitterreiter et al., Atomistic positioning of defects in helium ion treated single layer MoS_2, Nano Letters 20, 4437 (2020)

(4) J. Klein, L. Sigl, et al., Engineering the luminescence and generation of individual defect emitters in atomically thin MoS_2, ACS Photonics 8, 2, 669 (2021).

(5) E. Mitterreiter et al., The role of chalcogen vacancies for atomic defect emission in MoS_2, Nature Communications 12, 3822 (2021).

(6) K. Barthelmi et al., Atomistic defects as single-photon emitters in atomically thin MoS_2, APL Perspective 117, 070501 (2020).

(7) Hötger et al., Gate-switchable arrays of quantum light emitters in contacted monolayer MoS_2 van der Waals heterodevices, Nano Letters 21, 1040 (2021).

Xolography for volumetric 3D printing

Stefan Hecht

Leibniz Institute for Interactive Materials, Aachen, Germany;
Institute for Technical and Macromolecular Chemistry, RWTH Aachen University, Germany;
Department of Chemistry and IRIS Adlershof, Humboldt-Universität zu Berlin, Germany

Light-based additive manufacturing techniques offer various fundamental advantages due to the unrivalled speed and resolution of photopolymerization processes. This great potential, however, has been partially upset by slow build rates and material inhomogeneities due to point-wise or layered object generation. Volumetric 3D printing is the next evolutionary step to realize a continuous printing process. However, both currently established methods, two-photon photopolymerization and computed axial lithography, suffer from limited speed and resolution, respectively, which primarily originate from the necessity for a nonlinear process that defines a local polymerization threshold.

To overcome this limitation, we have developed xolography as a new and powerful volumetric printing technique. It is based on the use of photoswitchable photoinitiators that require a sequence of two one-photon processes taking place at distinctly different wavelengths. Therefore, these dual color photoinitiators enable the precise confinement of the polymerization into regions defined by two orthogonal light sources consisting of an activating UV/blue light sheet and an orthogonal visible light projector. Since the crossing (x) light beams generate an entire (holos) object by this printing process, we refer to it as xolography. The linear nature of the process in combination with the high-definition of the projection allow for rapid printing of homogeneous materials and complex multicomponent objects in high resolution and without the need for support structures.

The presentation will cover the action principle of xolography, discuss the performance of the method and resulting opportunities, and moreover highlight the development and transfer process in the startup company xolo GmbH, dedicated to commercialize the technology.

References:

[1] *Nature* **588**, 620-624 (2020). DOI: 10.1038/s41586-020-3029-7

[2] www.xolo3d.com