WWU MÜNSTER

Aktuelle Fragen
der Nanophysik

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Site-selectively generated photon emitters in atomically thin MoS_2

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Two-dimensional materials offer a wide range of perspectives for hosting functional and highly localized zero-dimensional states, e.g. vacancy defects, that offer great potential for nano-photonic applications. The site-selective generation of such defects and the fundamental understanding of their optical and electronic properties are of particular importance for a future integration in photonic devices.
In my talk, I will demonstrate the highly local generation of individual optically active defects in a monolayer MoS_2 van der Waals heterostructure. [1] The result is realized by irradiating monolayer MoS_2 with helium ions to generate optically active defect luminescence [2] and by hBN encapsulation of the defective MoS_2 to greatly enhance optical quality. [3] The subsequent encapsulation reveals narrow spatially localized spectral lines that exhibit emission that is redshifted by 100 - 220 meV below the neutral 2D exciton, whereas irradiation through a fully hBN encapsulated monolayer MoS_2 results in background free and highly homogeneous defect emission with a FWHM of 30 meV with an energy redshift of 193 meV. [4] Individual defects are spectroscopically investigated through photoluminescence excitation spectroscopy and temperature dependent measurements. The 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. We attribute the emission to atomistic defects induced by the helium ion irradiation and discuss their origin in the light of scanning tunneling microscopy measurements. [5] Finally, if time permits, I will discuss recent results from defects implanted in field-switchable van der Waals devices, magneto-optical spectroscopy and measurements at sub-K temperatures.

[1] J. Klein et al., Nature Comm. 10, 2755 (2019)
[2] J. Klein et al., 2D Mater. 5, 1 (2017)
[3] J. Wierzbowski and J. Klein et al., Sci. Rep. 7, 12383 (2017)
[4] J. Klein and L. Sigl et al., to be submitted (2019)
[5] J. Klein et al., Appl. Phys. Lett. 115, 261603 (2019)