Seminarankündigung

Dienstag, 14. Dezember 2021
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ONLINE via ZOOM

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"Spectroscopy and molecular beam epitaxy of TMDs on hBN"

Monolayer transition metal dichalcogenides (TMDs) are two-dimensional materials with exceptional optical properties such as high oscillator strength, valley-related excitonic physics, efficient photoluminescence, and several narrow excitonic resonances. However, the above effects have been explored so far only for structures produced by techniques involving mechanical exfoliation and encapsulation in hBN, inevitably inducing considerable large-scale inhomogeneity. On the other hand, techniques which are essentially free from this disadvantage, such as molecular beam epitaxy (MBE), have to date yielded only structures characterized by considerable spectral broadening, which hinders most of interesting optical effects. In this talk, I will present the MBE-grown TMD (MoSe2) exhibiting narrow and fully resolved spectral lines of neutral and charged exciton [1]. Moreover, our monolayers exhibit unprecedented high spatial homogeneity of optical properties, with variation of the exciton energy as small as 0.16 meV over a distance of tens of micrometers. Importantly, good optical properties are achieved for as-grown samples, without any post growth exfoliation and encapsulation in hBN. Our best recipe for MBE growth includes extremely slow growth rate, the annealing at very high temperatures, and the use of atomically flat hBN substrate in the form of exfoliated flakes. Moreover, comparable results are also obtained using an hBN substrate that we grow by MOCVD on 2" Al2O3 wafers [2]. Our optical characterization includes low-temperature PL, PLE, reflectivity, magneto-spectroscopy, time resolved spectroscopy and room-temperature Raman scattering and SHG [1,3]. I will compare structural and optical properties of MoSe2 grown on exfoliated hBN to properties of various TMDs (MoTe2 [4,5], NiTe2 [6], WSe2, VSe2) grown on various substrates (2D, 3D, polycrystalline). This reveals particularly high diffusion parameters of transition metals on hBN [5], the role of distribution of orientation of TMD grain domains, the tendency to merge grains or form bilayers and 3D structures.

[1] W. Pacuski et al., Nano Letters 20, 3058 (2020).
[2] K. Ludwiczak et al., ACS Appl. Mater. Interfaces 13, 47904 (2021).
[3] K. Oreszczuk et al., ready for submission (2021)
[4] Z. Ogorzałek et al., Nanoscale 12, 16535 (2020).
[5] B. Seredyński et al., ArXiv:2111.12433 (2021).
[6] B. Seredyński et al., Cryst. Growth Des. 21, 5773 (2021)

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