Understanding the interaction of the electron beam in 2D $MoTe_2$ at different voltages

Master Thesis, Electron Microscopy Group of Materials Science, Prof. Ute Kaiser

Background

Modern low-voltage transmission electron microscopes (TEM) reach single atom resolution at low acceleration voltages in the range of 20-80 kV [1,2,3]. This gives the possibility to study materials with low knock-on thresholds. But not only knock-on damage plays a role in radiation damage but also mechanisms like radiolysis, heating, charging and chemical etching. It was shown for MoS_2 at 80 kV that encapsulation of the specimen with graphene prevent against radiation damage [4]. Further experiments showed, that decreasing the acceleration voltage in the TEM results in an increase of the damage rate. Furthermore, experiments to evaluate the damage-cross section of $MoSe_2$ at 80 kV showed that the earlier employed method to distinguish the different damage mechanisms [5] seem to be not valid as the contribution for knock-on damage in $MoSe_2$ is similar to MoS_2. However the knock-on threshold for $MoSe_2$ is at 190 keV [4] (~90kV for MoS_2) and at an acceleration voltage of 80 kV the contribution of knock-on damage should be negligible small. **Aim**

The aim of the master thesis is to achieve a better understanding of the electron radiation damage effects at different voltages and find a theoretical description of the different processes as well as ways to distinguish the different damage mechanisms experimentally. Furthermore, the damage rates should be compared to the existing results for the isoelectronic MoS_2 [4].

Workplan

- introduction to electron microscopy, radiation damage, basics of $MoTe_2$
- fabrication of heterostructures using the exfoliation technique
- recording image sequences with aberration-corrected HRTEM at different voltages
- data post-processing of recorded image sequences and determination of the damage-cross-section
- theoretical description of the different damage processes **Requirements**

- good physical and mathematical understanding
- high interest in laboratory work
- enjoying autonomous, scientific work in an international environment

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The work will be performed on our newly developed SALVE microscope [3].

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[4] G. Algara-Siller, *et.al.* Appl. Phys. Lett. **103(20)**, (2013)
[5] H.P. Komsa, *et.al.* Phys. Rev. Lett. **109**, 035503 (2010)

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