SEM Transmission Diffraction Stage with 6-axis sample control and a pixelated detector with variable camera length

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Introduction

With the availability of fast cameras for electron diffraction a wide range of diffraction-based techniques has recently been developed for STEM, many of which can be readily realized also in a conventional SEM with just a few modifications to the sample holder, as will be elaborated in the following. We designed a transmission diffraction stage with 6-axis sample control for SEMs with a pixelated detector and a variable camera length. This stage can tilt and shift the sample with nanometer precision and simultaneously acquire the diffraction pattern in transmission of the illuminated sample area. With this stage it is now possible to apply many different STEM-based methods with the SEM while having the advantage of a simpler system compared to dedicated transmission microscopes as well as a larger sample chamber, less operating costs and access to low acceleration voltages. We will present our stage in more detail and show a summary of our results.

Instrument description

Our stage consists of a hexapod with a sample holder, a camera, a linear positioner to move the camera and a cooling unit for the camera. The hexapod shift ranges (x,y,z) are up to 20mm and the tilt ranges (α,β) are up to 38°. The smallest shift increment is 1nm with a unidirectional repeatability of ±15nm for 1mm travel range. The sample holder can fit standard TEM grids and is attached to the movable platform of the hexapod. It can easily be exchanged with a different custom version that allows for e.g. sample manipulation. The camera has a 1/1.2" sensor fiber-coupled to a scintillator and achieves 105fps at 2MPs (full resolution). The camera length can be changed from approximately 5mm to 40mm. Our stage is mounted to the standard SEM sample mount of our Zeiss GeminiSEM 500 and uses two flanges on the SEM door for the electrical feedthroughs. We have full scripting access to our SEM and already synchronized it with one of our transmission cameras.

Discussion

With our 6-axis stage it possible to tilt and shift the sample under the electron beam and acquire transmission diffraction patterns of the illuminated sample area in SEMs. Investigations in the SEM are potentially cheaper and faster than in (S)TEMs or even x-ray beam lines because of their lower cost and simplicity. Due to the large sample chamber it is easier feasible to add complex holders for sample manipulation like heating, cooling, liquid cells, mechanical manipulation, electrostatic and magnetic fields, etc.. Since the stage is mounted to a standard mount for sample holders and is designed as a plug and play system, it can therefore be easily adapted to other SEMs.

Outlook

We already implemented large angle rocking beam electron diffraction (LARBED) and strain mapping. We will present 3D reciprocal space maps as well as strain and orientation maps acquired using this system. Results of other, currently ongoing experiments will also be presented.

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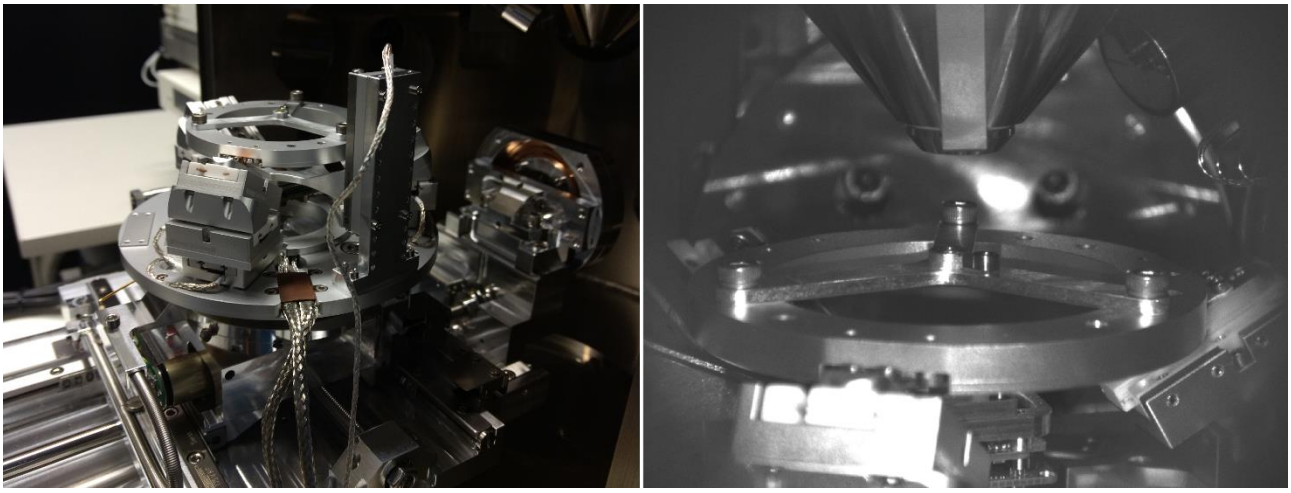

Image 1: Our 6-axis sample stage on top of the SEM sample mount (left) and our stage inside the sample chamber (right).