Relocation of defined sample positions with an automated stage navigation tool for SEM

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Introduction

For various applications in Scanning Electron Microscopy (SEM), the relocation of defined sample positions is very advantageous, i.e. for time dependent re-measurement of special features or investigations with different electron beam analyses techniques. For this reason we developed a software tool, which enables the relocation of sample positions with the help of defined reference marks. It allows repeated measurements at defined sample positions at different times as well as with different SEMs by control of the SEM sample stage. A special application is the high resolution measurement of nanomaterials. The acquired images are used to detect and classify fibers with an automated software approach.

Sample Navigation Tool „TiNa“

The introduced sample navigation tool “TiNa” is based on the manual measurement of four reference marks (1-4). For this reason, the corners of a silicon chip or a sample holder are applied. The software tool allows the registration of the stage positions of the reference marks, the transformation of already measured sample positions into the stage coordinate system and the control of the stage for the relocation of the positions of interest. TiNa uses the RS232 or TCP/IP interface for controlling the stage.

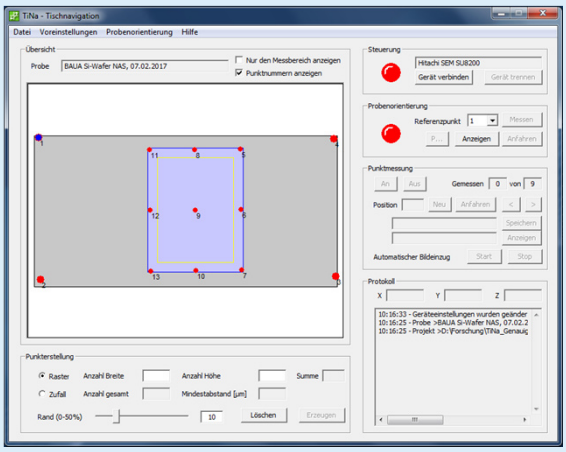


Fig. 1: Screenshot of stage navigation software with layout of test sample

Test Chip

For evaluation, a special test chip was designed and application tests were performed on three different SEMs. The silicon test chip has the size of the usually applied samples for nanomaterial collection. We used FIB etching for the creation of four reference marks and a grid of nine control marks in the sample center. The reference sample was measured with three different SEMs (Hitachi SU8030, SU8230 and FEI Helios NanoLab 600) at different times. After the re-measurement of the positions of the reference marks, the sample navigation tool reproduces the previously defined test positions. The remaining positioning errors were measured in the SEM images, which were acquired at these positions.

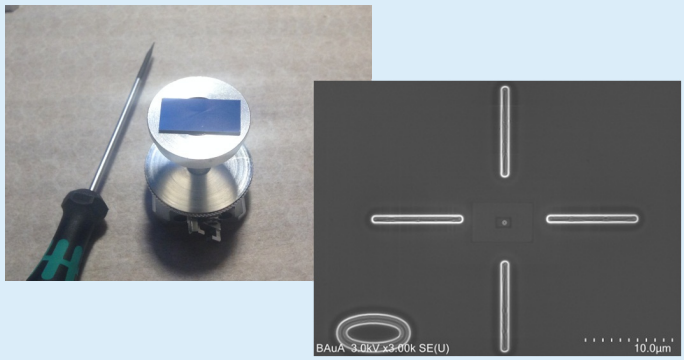
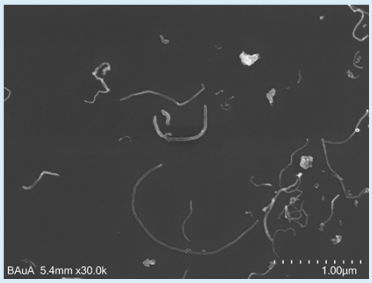


Fig. 2: left silicon test chip in the sample holder, right one control mark

Automated statistical based detection



TiNa was developed especially for the application of nanomaterial detection, which requires SEM images with a field of view of 42.2 µm x 31.7 µm with a pixel size of 8.2 nm at random sample positions. The aim is to do an automated statistical based detection and classification of nanomaterials as harmful to health.

Fig. 3:: SEM image of nanomaterials

Accuracy of repeated relocation

The accuracy of repeated relocation of the marks was investigated with the test sample; it is 1-5µm at the same SEM (SU8230), also with a remounted sample. The comparison with measurements on the second used SEM (SU8030) shows the relocation accuracy within the same size in that case. The performed test showed the easy-to-handle and precise functionality of the stage navigation tool.

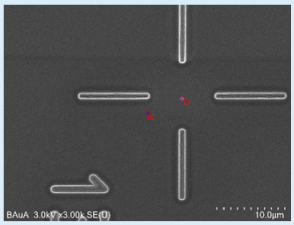


Fig. 4: Deviation of point no# 13

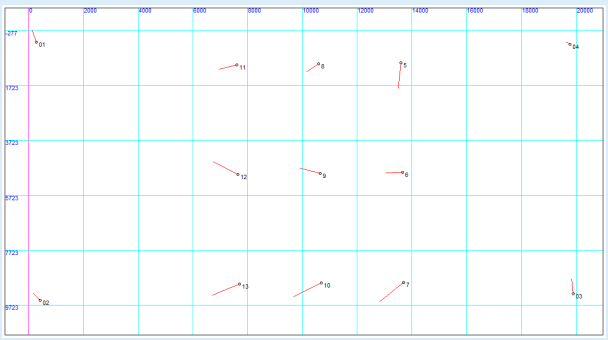


Fig. 5: Diagram with remaining deviations (vectors are 200 times scaled)

Residuals of transformed coordinates SU8030 and SU8230

	SU8030 2nd [µm]		SU8230 1st [µm]		SU8230 2nd [µm]	
Point Id	Res X	Res Y	Res X	Res Y	Res X	Res Y
01	-0.5	0.7	-0.3	-0.4	-3.4	-3.4
02	3.0	-1.5	2.0	-1.4	-2.4	0.8
03	0.2	-2.5	6.3	3.3	5.6	1.4
04	-0.3	-0.3	4.6	-2.1	5.1	-6.0
5	hidden	hidden	1.7	-6.5	1.1	-3.5
6	2.2	0.0	0.5	0.1	1.4	1.0
7	off	off	-1.6	2.8	-0.3	6.6
8	-1.3	1.4	-0.8	-2.9	-1.7	-3.7
9	-1.8	0.4	-3.0	1.7	-2.4	0.8
10	-1.3	1.3	-3.1	2.4	-1.1	6.3
11	-0.3	-0.2	-1.3	-3.3	-0.6	-5.0
12	0.2	0.8	-2.5	3.3	-0.3	0.6
13	off	off	-2.6	3.0	-1.0	4.1
Sigma XY	1.5		3.2		3.6	

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