Collaborative project*

Project acronym: SNM

Project full title: "**Single Nanometer Manufacturing for beyond CMOS devices**"

Grant agreement no: 318804

Deliverable: D4.2 ("Installation of AFM in SEM")

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List of participants:

Participant no.	Participant organisation name	Part. short name	Activity Type	Country
1 (Co)	Technische Universität Ilmenau	**TUIL**	HER	Germany
2	EV Group E. Thallner GmbH	**EVG**	IND; End-user	Austria
3	IMEC	**IMEC**	RES	Belgium
4	Mikrosistemi Ltd	**µS**	SME; End-User	Bulgaria
5	Universität Bayreuth	**UBT**	HER	Germany
6	Technische Universiteit Delft	**TUD**	HER	Netherlands
7	Spanish National Research Council	**CSIC**	RES	Spain
8	IBM Research GmbH	**IBM**	IND; End-user	Switzerland
9	École polytechnique fédérale de Lausanne	**EPFL**	HER	Switzerland
10	SwissLitho AG	**SL**	SME; End-User	Switzerland
11	Oxford Instruments Nanotechnology Tools Ltd	**OINT**	IND; End-user	UK
12	Imperial College London	**IMPERIAL**	HER	UK
13	The Open University	**OU**	HER	UK
14	Oxford Scientific Consultants Ltd	**OSC**	SME	UK
15	VSL Dutch Metrology Institute	**VSL**	IND	Netherlands
16	University of Liverpool	**ULIV**	HER	UK

SNM **Work Package <WorkPackageNumber>** **Deliverable: <DeliverableNumber> ("<DeliverableTitle>")**										
Lead beneficiary number	6	**Nature**	P	**Dissemination level**	PU					
Estimated Person-months	4									
Person-months by partner for the Deliverable	TUD									
	4									
Estimated Delivery Date	Mx: mm/yyyy 01/2016	**Delivery Date**	dd/mm/yyyy 02/02/2016							
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Reviewed by:	• WP4 Leader: Cornelis W. Hagen • WPG1 Leader: Armin Knoll • Coordinator: Ivo W. Rangelow									

Criteria and Achieved Results	**Criteria**	**Achieved result**
	Working AFM installed in the NovaNanoLab 650 SEM in Delft	AFM is installed and in operation.

Description of the Deliverable	• An AFM is purchased that is based on a fully electrical readout mechanism (no optics involved). This enables easy integration of the instrument in an existing SEM. The great advantage of this geometry is that inspection of nanometer size features with electron imaging can be combined in situ with AFM inspection. This way we expect to establish a relation between the actual shape of features and the corresponding top-down SEM image, learning how to measure linewidths from SEM images. In addition we can monitor the growth of EBID structures without having to take the sample out of the microscope. These capabilities are expected to contribute considerably to the metrology in single nanometer manufacturing. • The AFM was delivered on time by Nanoanalytik GmbH, and installed by their technicians. The AFM was tested in air, as well as in vacuum in the SEM. Scans of test samples were made and a short tutorial was given to two of our PhD-students. • Below a few images are shown of the AFM as installed in our SEM (Figs. 1 and 4), and the flange containing the electrical feedthroughs (Figs. 2 and 3). Also an SEM image of a test sample and the AFM cantilever as mounted under the SEM objective lens is shown in figure 5. An AFM image of the test sample is shown in Figure 6.

Fig. 1 The AFM as mounted on the stage of the FEI NovaNanoLab650 SEM

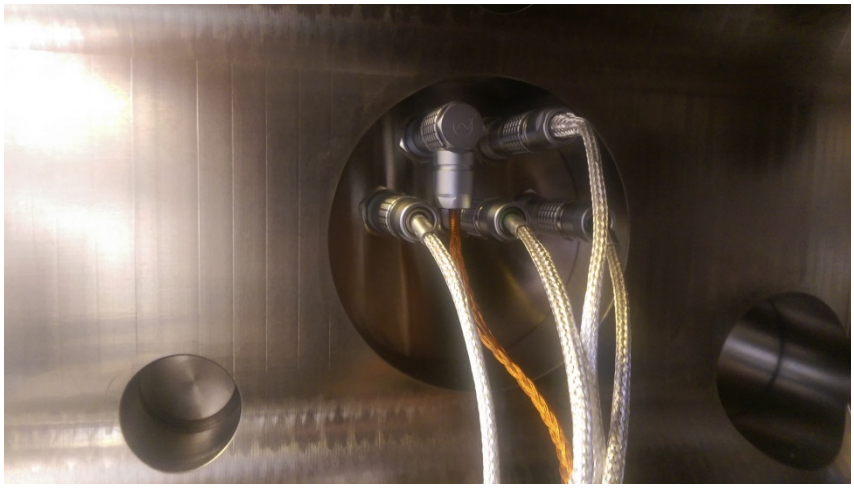

Fig. 2 The vacuum side of the flange containing the AFM electrical feedthroughs.

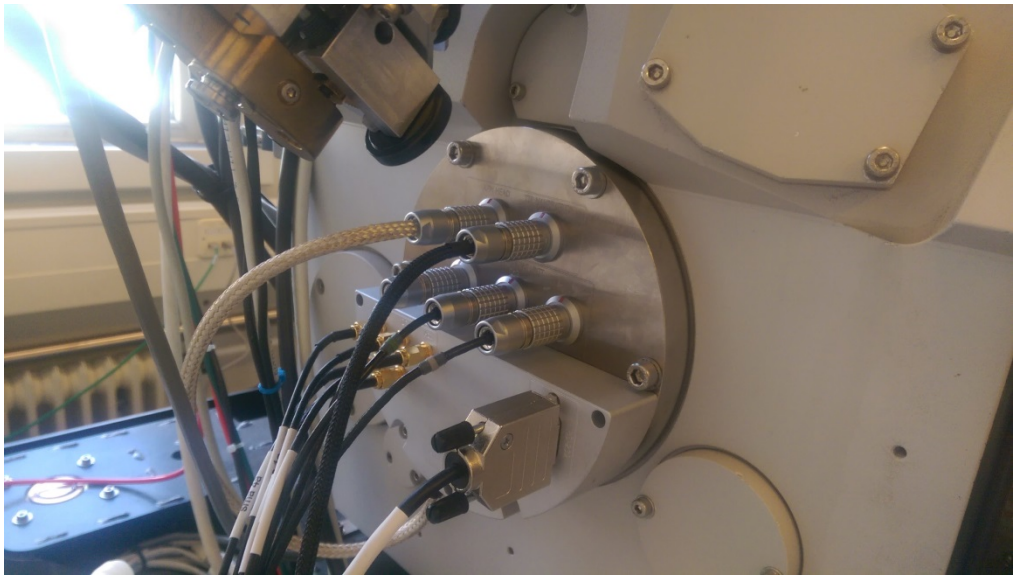

Fig. 3 The atmospheric side of the flange containing the AFM electrical feedthroughs.

Fig. 4 The geometry for AFM and SEM inspection

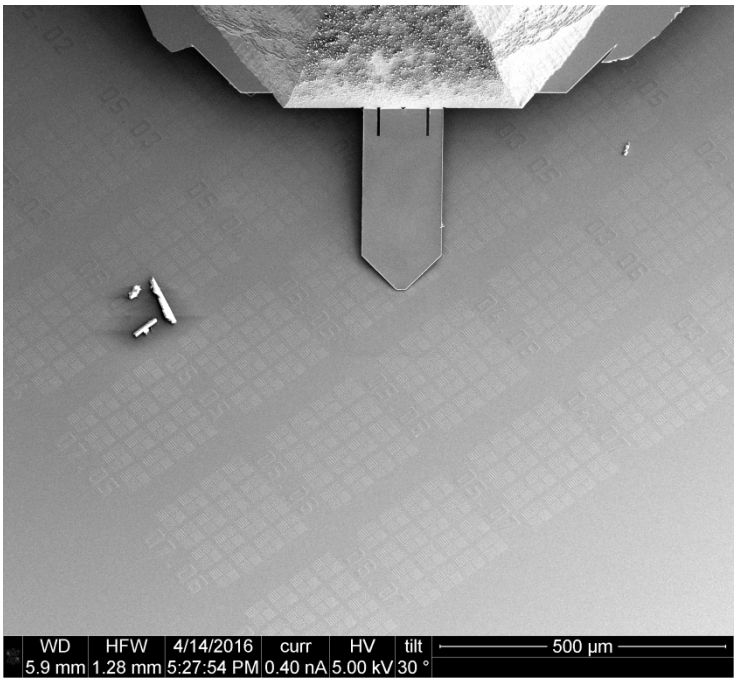

Fig. 5 An SEM image of the AFM cantilever and test sample

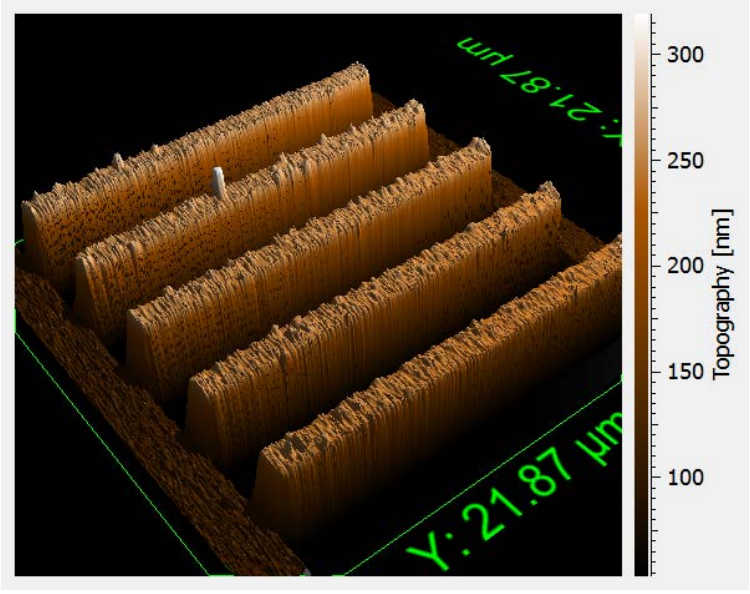

Fig. 6 An AFM image of the test sample shown in the previous image

Explanation of Differences between Estimation	There are none.

and Realisation	
Metrology comments	This instrument is dedicated to the metrology issues in the SNM project.