doi:10.1017/S1431927610063270
Microsc. Microanal. 16 (Suppl 2), 2010

Nanofabrication with a High Resolution Helium Ion Beam

Emile van Veldhoven*, Vadim Sidorkin**, Ping Chen**, Paul Alkemade**, Emile van der Drift**, Huub Salemink**, Henny Zandbergen** and Diederik Maas*

* TNO Science and Industry - Van Leeuwenhoek Laboratory, P.O. Box 155, 2600AD Delft, The Netherlands
** Kavli Institute of Nanoscience, Delft University of Technology, Lorentzweg 1, Delft 2628CJ, The Netherlands

To explore the possibilities of the Orion plus helium ion microscope (HIM) as a nanofabrication tool, the HIM at the TNO VLL is equipped with a pattern generator and a gas injection system. The nanofabrication research focuses on three areas: lithography, direct write and Helium Ion Beam Induced Processing (HIBIP)

Lithography of helium ions with negative and positive resists is being studied to obtain ultimate resolution combined with dense patterns. The helium ions interact very locally with the resist. As a result, we observe (almost) no proximity effects, not even at pattern densities of 50% and line widths below 10 nm. For a 5 nm thin HSQ resist layer, 6 nm lines with 15 nm pitch have been achieved as shown in Figure 1 [1].

One of the most simple direct write options is to sputter directly material with helium ions [2]. Au- and Pt-rods have been sliced to obtain small incisions. Figure 2 shows an 8 nm incision in Au-rods imaged with the HIM and TEM. The incision is slightly curved on the outside of the Au due to the surface tension. A limitation of direct write is the bubble formation in the substrate at extremely high ion dose, as investigated by Livengood et al. [3].

HIBIP is performed using the following precursors: Pt, TEOS and XeF_2. The Pt precursor is used to illustrate the possibilities of creating conducting 3D nanostructures. Figure 3 shows lines with dimensions of approximately 200, 15 and 30 nm (length, width and height). The same objectives are being investigated for TEOS precursors to fabricate non-conducting objects. XeF_2 has been tested for etching materials with high precision.

In conclusion, the helium ion microscope equipped with a gas injection system and a pattern generator is a new nanofabrication tool. It allows the user to modify and inspect samples on a nanometer scale with the same instrument.

References

[1] V. Sidorkin, E. van Veldhoven, E van der Drift, P. Alkemade, H. Salemink and D. Maas, *J. Vac. Sci. Technol. B* 27 (2009) L18

[2] D C Bell, M C Lemme, L A Stern, J R Williams and C M Marcus *Nanotechnology* 20 (2009) 455301

[3] R. Livengood, S. Tan, Y. Greenzweig, J. Notte and S. McVey, *J. Vac. Sci. Technol. B* 27 (2009) 3244.

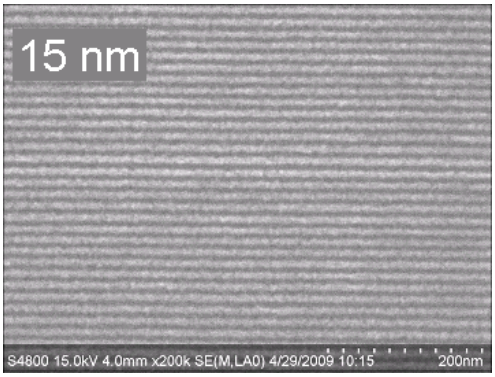

Figure 1: High density lines of HSQ with a width of 6 nm at a pitch of 15 nm

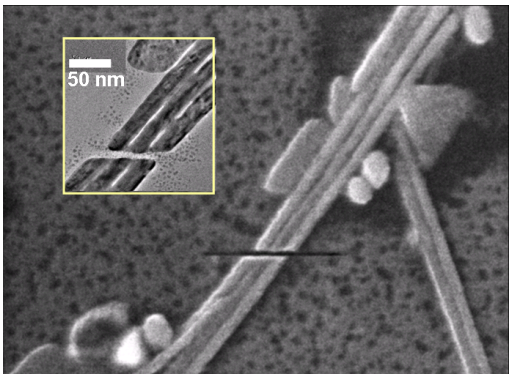

Figure 2: An 8 nm wide incision in Au bars made with helium ions and inspected by helium ion microscopy and TEM (inset).

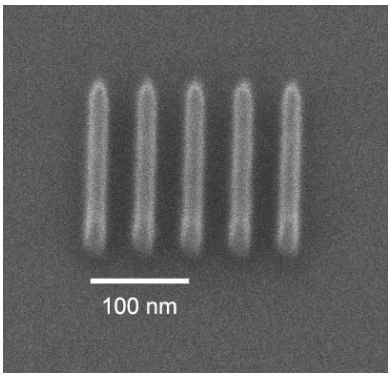

Figure 3: 15 nm Pt deposited lines with a pitch of 50 nm imaged with the helium ion microscope under an angle of 30 degrees

https://doi.org/10.1017/S1431927610063270 Published online by Cambridge University Press