doi:10.1017/S1431927622011746
Microsc. Microanal. 28 (Suppl 1), 2022
© Microscopy Society of America 2022

NanoMi: An Open Source Electron Microscope Component Integration

M. Malac[1,2], D. Homeniuk[1], M. Kamal[3], J. Kim[4], M. Salomons[1], M. Hayashida[1], J. A. Marin-Calzada[2], D. Vick[1], D. Price[1], R.F. Egerton[2]

[1] NRC-NANO, Edmonton, Canada.
[2] Department of Physics, University of Alberta, Edmonton, Canada.
[3] Electrical Engineering, University of Alberta, Edmonton, Canada.
[4] Electrical and Comp. Eng., University of British Columbia, Vancouver, Canada.

We are developing a public-license electron-microscope column referred to as NanoMi [1], whose electron optics is suspended inside a vacuum envelope based on ConFlat hardware, see Fig. 1. The design of individual components has been reported earlier [2]. We are now developing software control, column alignment procedures and integration of the components. A significant part of the work has been done by undergraduate students in our laboratory. Parts of the software and modeling are available for download from GitHub and from Open Science Foundation sites [3] and are released under a GPL v3 license [4]. An initial version of the blueprints is now shared on case-by-case basis.

The NanoMi column is based on electrostatic electron optics [5], reducing the heat generation during the lens operation. Each individual component, such as Einzel lenses, sample holder, aperture plates, deflectors and sigmators, is mounted on a support plate with standard dimensions, which attaches to a 5-inch diameter half-pipe with mounting holes every ⅓ of an inch, see Fig. 1b. The half-pipe acts as a breadboard, allowing the assembly of a wide variety of electron-optical configurations. All components are compatible with ultra-high vacuum. The column is designed for acceleration voltages up to 50 kV, although we currently utilize more affordable 30 kV power supplies. The target resolution is 10 nm in both TEM, SEM and STEM, and NanoMi will also provide electron-diffraction capability. We have developed an affordable scan reference signal generator and high voltage amplifiers for the beam deflector and stigmator plates, providing up to ±70V and ~2us minimum pixel dwell time with 12 bit analog to digital converters.

Manual control of NanoMi is adequate for testing individual components but computer control is critical for correct operation and the ability to easily reproduce component settings. The control software uses Python and PyQt. Fig. 2 shows an example of the hardware and its software control for aperture and sample movers.

References:

[1] M. Malac et al., Micr. and Microanal. **26** (S2) (2020), p. 1810-1811.
[2] M. Malac et al., Micr. and Microanal. **27** (S1), 1062-1063.
[3] nanomi.org and https://osf.io/bpj73, DOI: 10.17605/OSF.IO/BPJ73
[4] https://www.gnu.org/licenses/gpl-3.0.en.html and https://opensource.org/CERN-OHL-W
[5] G. Rempfer, J. Appl. Phys. **57** (1985), p. 2385.

https://doi.org/10.1017/S1431927622011746 Published online by Cambridge University Press

Fig. 1

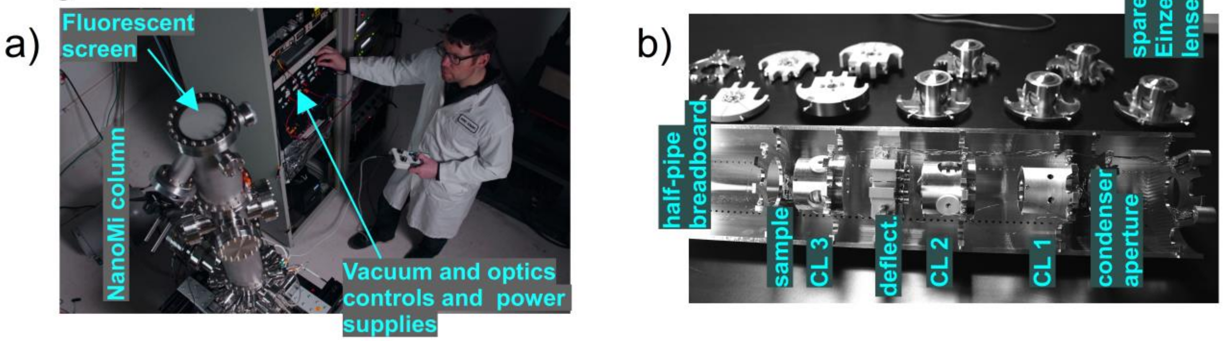

Fig. 2

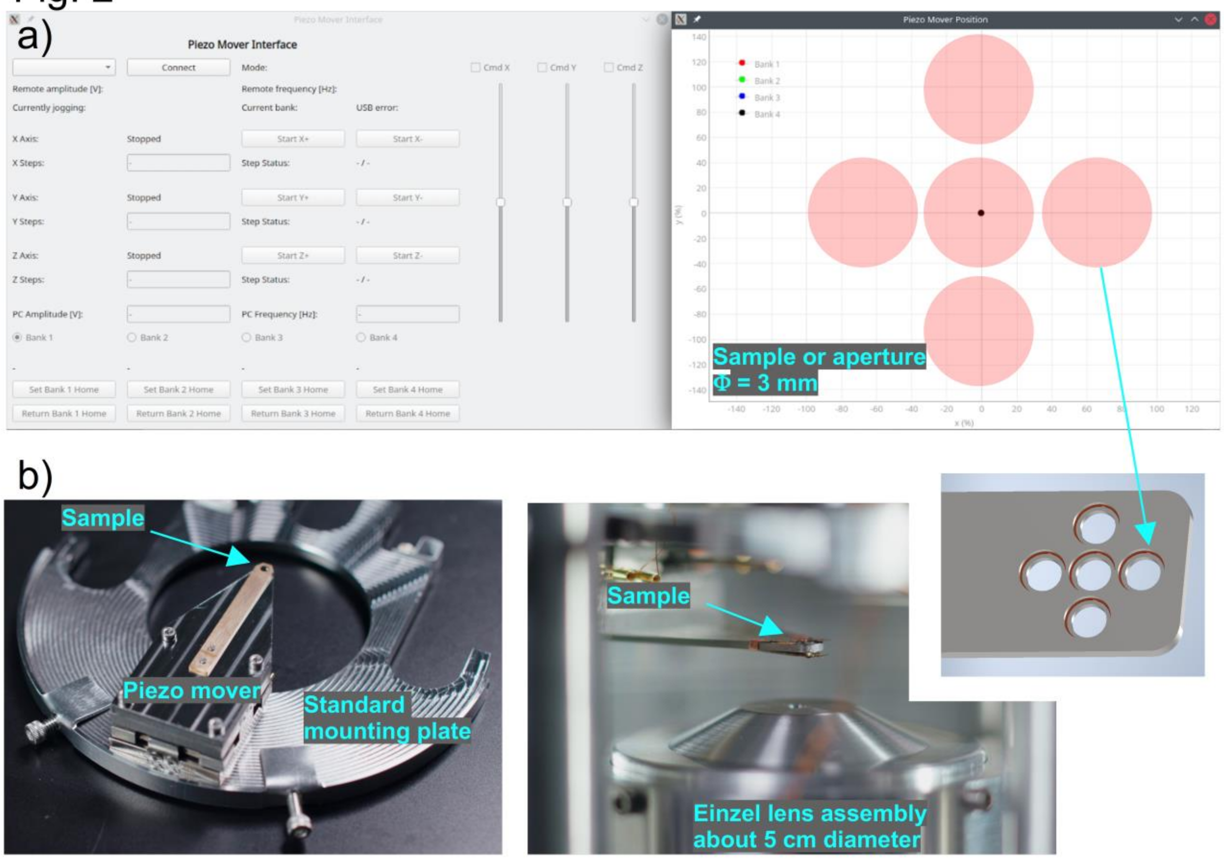

Figure 1. a) Top view the NanoMi column. b) half pipe with mounted components, together with mounting plates and lens assemblies. Our NanoMi has its electron gun located at the bottom, but any orientation is possible.

Figure 2. a) An example of software control of the NanoMi sample and aperture-positioning hardware. b) The positioning hardware is based on piezo movers, allowing 10 mm travel with 20 nm step in both *x* and *y*. Sample tilt and *z* motion is not yet implemented. The bottom panel shows the standard mounting plate with piezo mover and a single sample position attached. Right bottom panel shows the same sample plate near the third condenser lens. The updated sample or aperture mounting plate holds five 3 mm diameter sample grids or aperture plates (inset).

https://doi.org/10.1017/S1431927622011746 Published online by Cambridge University Press