Programmable Aperture Plate System with integrated CMOS electronics for projection maskless nanolithography and nanopatterning

Christof Klein [a*], Elmar Platzgummer [a], Hans Loeschner [a],
Florian Letzkus [b], Michael Jurisch [b], Mathias Irmscher [b], Martin Witt [c], Wolfgang Pilz [c]

[a] *IMS Nanofabrication AG, A-1020 Vienna, Austria*
[b] *Institute für Mikroelektronik Stuttgart (ims-chips), Stuttgart, Germany*
[c] *Fraunhofer Institut for Silicon Technology (ISIT), Itzehoe, Germany*

Projection maskless nanolithography and nanopatterning techniques are based on the use of a programmable Aperture Plate System with integrated CMOS electronis (CMOS-APS) as shown in Figure 1a. The CMOS-APS consists of an Aperture Plate, which splits a broad telecentric beam of electrons or ions into a multitude of micrometer-sized beamlets, and a Blanking Plate with integraterd CMOS electronics, which allows for individual deflection of each beamlet. The beamlets formed by the Aperture Plate pass through larger openings in the Blanking Plate which is in proximity to the Aperture Plate (Figure 1b). At each openings of the Blanking Plate there are ground and deflection electrodes. When a blanking electrode is powered on by the CMOS electronics the beamlet passing through is slightly deflected, which is sufficient to be filtered out at the last cross-over of the projection charged particle optics between CMOS-APS and substrate (cf. Figure 1a).

Operational 43k-CMOS-APS units were realized using an Aperture Plate with 43,008 openings of 2.5 µm x 2.5 µm size within a 5.76mm x 6.72mm field (Figure 2). The 2.5 µm beamlets, thus generated, are demagnified by a factor of 200, providing the ability to work on the substrate with thousands of electrons or ion beams of < 20nm size in parallel (Figure 3).

For future production systems it is planned to realize CMOS-APS units with several 100,000 beams.

* christof.klein@ims.co.at

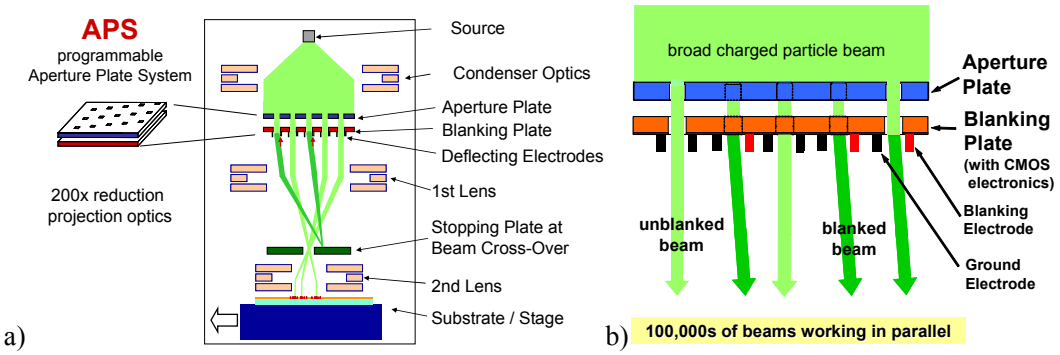

Figure 1: Principles of a) Projection Mask-Less Nanolithography / Nanopatterning, and b) programmable Aperture Plate System with integrated CMOS electronics (CMOS-APS)

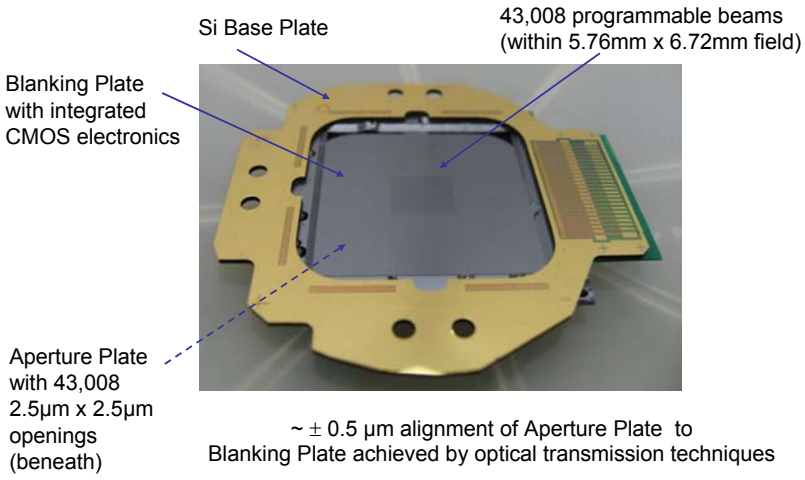

Figure 2: 43k-CMOS-APS unit

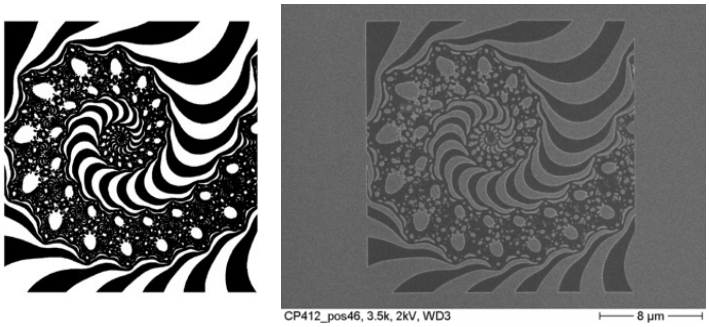

Figure 3: CMOS-APS operated projection tool exposure results as obtained with 10 keV Hydrogen ions in 50 nm HSQ resist with 20 µC/cm^2 exposure dose: Data input to CMOS-APS (left) and exposed 20 µm x 20 µm pattern (right).