EUV lithography in pre-production mode

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In the first half of 2011, the ASML NXE:3100 pre-production tool was installed in the imec 300mm cleanroom. The NXE:3100 is equipped with a laser-assisted discharge produced plasma source from XTREME technologies, and is interfaced to a TEL Lithius Pro for EUV track. Compared to its forerunner, the ASML EUV Alpha-Demo Tool, the NXE:3100 allows exposure across full scanner field. Because its throughput is sufficiently high for wafer batch exposure, it is a true pre-production tool. At the same time, the NXE:3100 places more stringent requirements on reticles and resists, and infrastructure to support the NXE:3100 operation has to be developed. All these activities take place in the imec Advanced Lithography Program, and we review the progress in various fields after one year of NXE:3100 operation.

To characterize the NXE:3100 for imaging, we discuss the control of CD across field, wafer and wafer batch. For printing a design in EUV lithography, a correction is needed for proximity, but also for the EUV specific effects of shadowing and flare. Flare was measured using a Kirk test, and compared to calculated flare levels using the lens point-spread function. A dataset on wafer was collected for contact hole patterns, and modeled using OPC software. A fit of the experimental data to within <1.5nm rms was possible, which proves the readiness of the design correction software. For overlay characterization, mixed and matched overlay data were collected of NXE:3100 versus ASML XT:1900i and ASML NXT:1950i.

For resist process development, the resists first have to pass the outgassing qualification tests. A dedicated setup for outgassing tests was developed at imec. In a second phase, the resists can be tested on NXE:3100 using off-axis illumination to reach sub 22nm resolution. Apart from screening based on imaging performance, tests that are closer to manufacturing are also done, such as tests for process defectivity. The NXE:3100 also has requirements for EUV mask making and mask handling: EUV mask handling must be done in such a way that particles are avoided, or can be removed by cleaning. Apart from the difficult requirement of being defect-free, the EUV masks must show improved uniformity at ever smaller dimensions on mask.