E-BEAM MASKLESS NANOLITHOGRAPHY AND ION-BEAM NANOFABRICATION

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Abstract

High-volume masked-based lithographic techniques are being pushed further implementing 193nm immersion techniques to reach the 45nm node and possibly even below [1]. Thus, despite of substantial mask set expenses, the cost of ownership of high-volume semiconductor device manufacturing can be kept at attractive levels [2]. Though, there is an increasing demand of leading edge chip prototype developments [3] and of fast-turnaround low-volume device manufacture at reasonable costs, which only can be met by mask-less lithographic techniques.

In this talk the potential of electron – beam based Projection Mask-Less Lithography (PML2, [4]) is explained to obtain ≥ 5 WPH (300mm) throughput for the 45nm, 32nm and 22nm nodes, and below, even when assuming single layer resist exposure doses of 18, 36 and 72 μC/cm^2, respectively, in order to obtain sufficiently low line edge roughness (LER).

In PML2 a low energy (5 keV) broad electron beam is structured into several 100.000 beamlets (5μm for the 45nm node) which individually can be blanked off. The dynamic e-beam pattern, as generated by the programmable aperture plate, is accelerated to 100 keV energy and is projected with 200x reduction to a resist coated wafer on a scanning stage. The different contributions to resolution and dose latitude will be analyzed as well as PML2 wafer stage and overlay parameters.

The European MEDEA+ project T409 has been started to realize a PML2 proof-of-concept tool [5, 6]. In parallel, PML2 wafer throughput and resolution possibilities are being studied.

When using ion-beams, in particular Argon or Xenon ions, there is the possibility of direct micro- and nano-machining as well as precursor gas supported ion beam induced etching or deposition. A novel Projection Focused Ion multi-Beam (PROFIB) tool is being developed implementing 100x – 200x reduction optics. There are promising PROFIB applications for semiconductor process diagnostics and for nanotechnology fields such as nano-magnetics, nano-photonics, and bionanotechnology as well as with respect to the fabrication of stamps for nanoimprint lithography.

PROFIB applications fields are being explored by the consortium Micro@Nanofabrication – Austria (MNA) as part of the Austrian Nano-Initiative.

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