

EMLC 2023 in Dresden with Record Attendance

After a 4 year break, the European Mask and Lithography Conference (EMLC) took place once again in Dresden in June 2023. At its 38th event, the conference was able to set a new attendance record with about 200 participants. The participants were again offered a rich program in Dresden from Monday afternoon to Wednesday evening with 38 oral presentations (including 5 keynotes and 11 invited presentations), 12 posters and 2 tutorials. The contents of these presentations reflected the current focus and development directions of mask and lithography technology, but also covered general aspects of the semiconductor industry.

High-profile program enthused conference participants

“Killer applications” – one of the major and often neglected problems of modern computer use

Right at the beginning, the very first keynote talk by Giacomo Indiveri (ETZH Zurich) showed alternatives for one of the major and often neglected problems of modern computer use - the excessive energy consumption of some "killer" applications. While Bitcoin miners recently outpaced the energy consumption of small nations, it is now estimated that Artificial Intelligence applications (language models, image generators such as ChatGPT, Dall E, etc.) will need to consume about 20% of global energy generation in just a few years if development continues as it is. A possible alternative could be "Neuromorphic Intelligence", i.e. a completely different computer architecture, which is oriented towards the functioning of biological brains and promises to achieve comparable performance with energy consumption reduced by a factor of 100 to 1000. A promising component for the realization of such units is the so-called memristor. The interested reader will find sufficient further articles on this topic. For the entire process chain, this promises to be an exciting challenge about how such components can be optimally integrated into the semiconductor production process.

Fascinating insights into the development and financial challenges of the semiconductor industry

Further keynotes by Joe English (Intel), Christian Koitzsch (Bosch) and Dominik Thron (Infineon) about the new semiconductor fabs in Leixlip, Ireland (Intel), in Dresden (Bosch, Infineon) and in the future in Magdeburg (Intel) gave a fascinating insight not only into how the semiconductor industry in Europe will develop further under the influence of supply chain issues and new funding programs, but also into the tremendous financial and organizational challenge to build a modern semiconductor fab and to operate with profit.

The largest part of the presentations was dedicated to the current developments in mask and lithography technologies, with the greatest challenges however to be seen in the further development of EUV lithography (extreme ultraviolet, wavelength 13.5 nm). While currently commercially available high-end electronics are manufactured in 7nm or 4nm processes, the roadmaps for semiconductor technologies suggest that in the next few years technology nodes will be called, for example, A20 or A14, corresponding to 2 nm and 1.4 nm, respectively! To be able to image such structures, the current EUV technology has to be further developed significantly in all aspects. In the case of exposure devices, the main role is currently played by a certain property of the optical system, the numerical aperture. In available devices, this value is 0.33 - but to be able to image structures of an A20 or A14 process, a numerical aperture of 0.55 or greater is needed.

This means, above all, that the individual components of the optical system must become larger without sacrificing accuracy. The elements of the optical system are exclusively mirrors with aspherical surfaces and then in sizes of up to one meter in diameter. Here, the actual surface must not deviate from the ideal surface shape by more than about 20 pm on average - precision that is beyond normal comprehension. Several presentations by Zeiss and ASML showed in great detail the huge effort required to manufacture and test such an optical system or the entire exposure device.

Other presentations were devoted to other important components of the lithography process,

the masks and photo-resists. EUV masks are principally flat mirrors, which carry an absorber layer on the surface. The desired structure is imprinted into this absorber layer by another lithography process. However, complex interactions with the optics of the exposure device must be taken into account when imaging this structure on the wafer. Currently, the goal is to better understand these interactions and use them for more accurate imaging. It also became clear for the photoresist that further research will be necessary in order to be able to stably render A14 structures in the developed resist in a few years' time.

A separate session with 4 presentations was dedicated to electron beam lithography,

which is primarily - but not only - needed for the production of masks including EUV masks. For high-end masks, multibeam mask writers from IMS Nanofabrication Vienna have been established for several years, later NuFlare Technology has also appeared as a supplier. In electron multibeam devices, mask structures are written simultaneously with a large number of partial beams (currently about 250,000). As a major advantage, the mask write time becomes independent of the size and number of micro- and nanometer structures, and a typical high-end mask can be written in about 10...12 hours or less. However, each partial beam writes a single pixel of fixed size, so in principle no structures smaller than those of pixel size can be created. Presentations by both companies outlined the current status and prospects for future technology nodes (smaller pixels, more beams), and the presentation by IMS Nanofabrication Vienna went into technical details of the realization.

Several presentations indicated that the trend toward chips with ever larger areas and more transistors and functions (Systems_on_Chip, SOC) could come to an end and even reverse. Two factors in particular could be responsible for this. As structure sizes continue to shrink, the likelihood of defects increases and that reduces yields. If the chips remain smaller, on the other hand, yield improves. A second factor is the future introduction of high-NA exposure devices (numerical aperture ≥ 0.55) and the anamorphic optics they require. This reduces the available area on the mask by half. If the usable area is too small for one (large) chip, the chip has to be split on two masks, which would be gladly avoided because of higher mask costs and new stitching problems. Of course, the smaller chips must then be reassembled into larger functional units using so-called interposers. Suitable technologies for this are based, for example, on nano-imprint lithography, examples of which were presented.

Without going into further details here, the presentations in the sessions on metrology, maskless lithography, lithography with technologies that have been available ("mature") for some time, such as DUV (wavelength 193 nm), and data analytics / AI also offered exciting new information.

Future oriented: Student Presentations

The format of a separate session exclusively for student contributions as oral presentation and additional poster, which was started last year, was also continued with great success. For the best contribution (oral presentation plus poster design), Carl-Zeiss-AG again offered the "Zeiss Award for Talents in Photomask Industry". This year the award went to Sean D'Silva from Fraunhofer IISB in Erlangen for his contribution "Predicting resist pattern collapse in EUVL using machine learning".

Not to forget: Networking – a top priority!

For all participants, the conference breaks, the exhibition accompanying the conference with 10 companies, the get-together on Monday evening and especially the conference dinner on Tuesday evening in the historic Pulverturm in Dresden offered good opportunities for professional exchange with colleagues and companies from our industry.

Overall, EMLC 2023 was again a very interesting conference that provided all attendees with an up-to-date cross-section of the status and perspectives in the lithography environment.

The next EMLC will be held in Grenoble from June 17 to 19, 2024.

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