EMLC 2026 – The “European Mask and Lithography Conference” comes to Jena for the first time

The 2026 EMLC conference was organized by the VDE/VDI Society for Microelectronics, Microsystems, and Precision Engineering GMM and, for its 41st edition, was held in Jena for the first time - the city of Carl Zeiss and Ernst Abbe, the “City of Light.” From June 22 - 24, 2026, researchers and developers from around the world gathered at the historic Volkshaus Jena to discuss the current state of mask and lithography technology. Since last year, Ines Stolberg (Vistec Electron Beam) and Jo Finders (ASML) have jointly taken over leadership of the conference, while Hans Löschner (IMS Nanofabrication, Vienna) continues to serve as Program Chair.

Approximately 250 participants from 21 countries and three continents (a new attendance record) attended 16 sessions featuring 46 presentations and 26 posters - including 4 keynotes, 10 invited talks, and 8 student presentations.

Keynote Presentations

Right from the very first presentation - the keynote by Prof. Anthony Yen, Vice President at ASML and Head of the Technology Development Center - it became clear why a conference on this topic was held in Jena. In his presentation titled *“Imaging near the resolution limit: from Abbe’s theory of microscopy to high-NA EUV lithography”*, he spanned a bridge from 1873, the year in which Ernst Abbe documented his fundamental formula for the resolving power of optical systems, through the various stages and wavelengths of lithography technology, all the way to the present and future with ASML’s latest and most sophisticated EUV lithography systems. Almost every presentation and almost every paper on lithography topics refers in some way to the Abbe equation, which describes how the maximum resolving power of an optical system is determined by the wavelength of the radiation used, the refractive index of the medium, and the aperture angle of the optical system (this equation is often referred to as the Rayleigh equation, but this is historically incorrect, as Rayleigh addressed a slightly different problem - and did so about six years later). In his keynote address, Prof. Anthony Yen vividly illustrated how the steady progress of our industry is linked to this fundamental insight which was discovered in Jena approximately 155 years ago.

The second keynote by Prof. Tünnermann, Director of the Fraunhofer IAP in Jena, also focused on Jena’s contributions to scientific progress - in the present day. In his keynote, he discussed findings regarding the application of current lithography technologies in micro- and nano-optics and the integration of microelectronic and photonic functions on a single chip to enable faster data transmission. One particularly outstanding recent achievement is the fabrication of a special optical grating for a spectrometer on ESA’s GAIA satellite which has taken our view of the Milky Way and our immediate cosmic neighbourhood to an entirely new level.

The keynote by Dr. Jin Choi, Vice President of Technology at Samsung Electronics Co., Ltd., then focused on the development and current state of mask technology at Samsung and in the semiconductor industry in general. A key part of the presentation was the report on the results of a survey of 16 leading companies in the mask industry (mask manufacturers and equipment manufacturers) regarding the future directions of this technology, which is continually approaching its physical limits.

Some of the findings are:

- There are no apparent alternatives to mask-based lithography as the core technology of semiconductor production
- In addition to the general roadmap for the semiconductor industry, a specific roadmap for the future requirements of the mask industry should be established
- The possibility of a different mask format should continue to be considered (due to the optics in high-NA EUV systems, very large chip designs no longer fit on a single mask and must be distributed across two or more, therefore, instead of the current 6-inch masks, there may be 6 x 12-inch masks or round masks with a 300-mm diameter in the future, even if this requires enormous investments in adapted infrastructure)
- The risks for research and development in this area are becoming so great that economic survival may require a strategy of limited cooperation among companies that are otherwise in fierce competition - a so-called “co-opetition.”

The fourth keynote of this conference, delivered by Dr. Clemens Neuenhahn, Head of ZEISS Semiconductor Mask Solutions at Carl Zeiss SMT, provided a fitting overview of the challenges - both those already overcome and those expected - for the equipment with which Zeiss SMT contributes to the mask ecosystem - primarily equipment for measuring, qualifying, and repairing masks.

Eye-catching at second glance …

While the keynotes and invited presentations mostly addressed the core topics of this conference, the event consistently succeeds in incorporating interesting and important topics that might not seem to belong at first glance. This year, two presentations in particular caught the attention: First, Prof. Timo Mappes’ presentation on the redesign of the German Optical Museum in Jena provided a very detailed insight into the plans for honouring the unique history of the optical industry in Jena and making it accessible to a broad audience. With completion scheduled for 2028, Jena will gain an attraction which will have an impact far beyond the region.

At the conference’s technical exhibition, a booth from the German Optical Museum offered a preview of what visitors can expect once the project is completed. Dr. Markus Keller’s (Fraunhofer IPA) presentation addressed a topic that is becoming increasingly important with the introduction of high-vacuum systems (EUV equipment!) into chip manufacturing facilities: the detection and control of condensing chemical contaminants that are “introduced” from the environment, which can quickly cause damage in vacuum areas and are difficult to remove.

As in previous years, a number of presentations addressed a problem that has arisen with the emergence of curved (curvilinear) structures on masks. One source of such structures - among others - is a technology known as “inverse lithography.” The geometric structures of the mask are created by calculating - taking into consideration the optical parameters of the imaging system- how the mask’s geometry must be designed so that the exact required geometry is produced on the wafer when the mask is imaged. Typically, this results in a geometry that contains almost no straight edges and only vaguely resembles the desired geometry. Conventional algorithms for CD or registration measurement fail when applied to such structures. In the meantime, many new algorithms - often heavily supported by AI - have become established in this field, enabling reliable measurements once again; without these, stable mass production of semiconductors cannot be maintained.

Two sessions addressed topics related to EUV lithography. A great deal of effort continues to be devoted to research on suitable resists (photoresists) in order to ensure that the maximum achievable resolution of EUV systems is also reflected in the resist after development. As the power of the EUV light source increases, the properties of the so-called pellicle (a protective film that shields the mask from contamination by dust particles) remain an important area of research. To date, pellicles made of carbon nanotubes have become the standard. One presentation detailed the advantages of a beryllium-based film (higher transparency, where even a few percent improvement is valuable) and the challenges (fragility, toxicity). With the transition to hyper-NA EUV systems (i.e., with a numerical aperture of 0.75) expected by around 2030 and the associated increase in the light intensity acting on the mask, this topic remains highly relevant. Another major challenge - addressed in several contributions - in connection with the further increase in resolution capacity through Hyper-NA is the growing influence of the mask's 3D effects, which can no longer be modeled as two-dimensional (flat) geometry. This is particularly a matter of computer models for simulating the exposure process and adjusting the illumination system in the EUV tool.

At the start of any lithography process (one response in the survey mentioned above on the future of the mask industry was: "no mask, no chip"), a properly fabricated mask is still required. Both the further development of mask writers (multi-electron-beam systems from IMS Nanofabrication and NuFlare with approximately 500,000 beams) toward system generations that meet the high-end requirements of future technology nodes (A14, A10), as well as the capabilities and application areas of the shaped-beam systems from Vistec Electron Beam Jena, were presented in detail. Several presentations also focused on the speed and quality improvements that can be achieved with shaped-beam systems using new approximation and cell projection strategies. These are primarily used in rapid prototyping and the fabrication of photonic nanostructures. For example, the aforementioned grating spectrometer for the GAIA mission was fabricated on a Vistec system.

Zeiss Award for Talents in Photomask Industry

The "Zeiss Award for Talents in the Photomask Industry" is presented annually for the best student presentation. This year, the award went to the paper *"Surface-sensitive metrology on periodic nanostructures with various X-ray methods"* by Vinh-Binh Truong (PTB).

In addition to presentations in the form of talks or posters, the technical exhibition, the Get-Together on Monday evening, and the conference dinner on Tuesday evening are all part of the EMLC's regular program, offering ample opportunity for conversations and in-depth discussions on the conference topics. This year, the dinner took place at "Imaginata," an industrial heritage site with the charm of the 1920s, a former substation. So that's why we had macro-electronics instead of microelectronics that evening. In the adjoining halls, designed in the late Bauhaus style, the interested audience was offered a variety of physics experiments to try out for themselves, ensuring that the evening came to an entertaining close with a mix of a dinner buffet and hands-on activities.

Highlights of a completely different kind

Two highlights of this EMLC 2026 should not go unmentioned here: On Monday morning, a guided city tour was offered with a special focus on the city's scientific and economic history; this attracted no fewer than 80 participants (divided into several groups), primarily international attendees. Additionally, during conference breaks, attendees were able to tour the interior of the Abbe Monument (which is not otherwise open to the public and is located directly next to the conference building).

The 42nd EMLC conference will take place in Dresden on June 15-17, 2027.

Dr. Reinhard Galler, EQUIcon Software GmbH Jena