High-NA EUV Progress and Outlook

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While EUV systems equipped with a 0.33 Numerical Aperture (NA) lens are increasingly being applied in high volume manufacturing, ASML and ZEISS have in parallel ramped up their activities considerably on an EUV exposure tool with an NA of 0.55.

The purpose of this so-called high-NA scanner, targeting an ultimate resolution of 8nm, is to extend Moore’s law for at least another decade.

A novel lens design, capable of providing the required Numerical Aperture, has been identified; this so-called anamorphic lens will provide 8nm resolution in all orientations. Paired with new, faster stages and more accurate sensors providing the tight focus and overlay control needed it enables future nodes.

In this paper, a short overview of the current state of the 0.33NA technology will be given, after that the advantages of High-NA will be outlined, especially for managing the needed extreme low defect printing rates while maximizing the effective throughput for patterning economics. The imaging performance is being simulated based on expected surface figures of the illumination and projection optics. A path towards extending the capabilities of the high-NA system by reducing the imaging $k_1$ with advanced masks and illumination options will be outlined.

Next to this, an update will be given on the status of the developments at ZEISS and ASML. Buildings, cleanrooms and equipment are being constructed, mirror production is ramping up, many tests are carried out to ensure a smooth implementation.

Figure 1: The High-NA exposure tool leaves the mask unchanged by limiting the angles of the light on the mask, despite the larger NA. The resulting lens has a circular pupil at the wafer, allowing for 8nm resolution, irrespective of the orientation of the features.
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After his study Electrical Engineering (Cum Laude) at Twente University of Technology. He received his PhD in Physics on the subject of non-linear optical waveguide devices in 1994 and held a post-doc position studying waveguide based electro-optical modulators.

He joined ASML in 1996 and was Project Leader for the Application of the first 5500/500 scanner and its successors up to 5500/750. In 2001 he became Product Development Manager of Imaging Products (DoseMapper, Customized Illumination). In 2007 he joined the dept of System Engineering. He was responsible for the Optical Columns of the 0.25NA and 0.33NA EUV systems. After this he worked on the design of the EUV source. He was the study leader of the High-NA EUV system and is now responsible for the High-NA optical train.

He is a Sr. Member of the SPIE, holds over 35 patents and presents frequently at conferences about photo lithography