Free-electron lasers and the future of EUV lithography

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Abstract:
In order to contain photon shot-noise and the resulting process variations and defects, high power light sources will be needed to extend EUV lithography. Moreover, efficient control of polarization will be required to maximize optical contrast at high numerical apertures (NA). Similarly, EUV lithography at a wavelength shorter than 13.5 nm will require alternatives to tin-based laser-produced plasma (LPP) light sources. Free-electron lasers (FELs) have the potential to address all of these issues. However, to be suitable as light sources for semiconductor R&D and high volume manufacturing, issues such as reliability and flexibility will need to be addressed. In addition to factors related to the light source, there are other issues that will limit the extension of EUV lithography. Many limiting factors involve imaging materials, such as resists. Because of mask 3D effects, new mask materials may be required, and computational lithography for high-NA EUV will be very complex. Solutions for these additional issues will be needed to enable fully the nodes at which FEL's would be used as EUV light sources.

Biography:
Harry J. Levinson is currently an independent lithography consultant. He spent most of his career working in the field of lithography at several companies – AMD, Sierra Semiconductor, IBM, and GlobalFoundries. Levinson served for several years as the chairman of the USA Lithography Technology Working Group that participated in the generation of the lithography chapter of the International Technology Roadmap for Semiconductors. He has published numerous articles on lithographic science and is the author of three books on lithography. He holds over 70 US patents. Levinson is an SPIE Fellow, previously chaired the SPIE Publications Committee, and served on SPIE's Board of Directors. In recognition of his contributions to SPIE, he received the Society's 2014 Directors' Award. In 2022 he received the SPIE Frits Zernike Award in Microlithography. Levinson has a Ph.D. in physics from the University of Pennsylvania. His Ph.D. thesis, titled "Resonances and Collective Effects in Photoemission," addressed certain phenomena involving the interactions of light and matter. For this work, he received the Wayne B. Nottingham Prize in surface science.