Fundamental Studies of EUV Lithography Including Shorter Wavelength at NewSUBARU Synchrotron Light Facility (Keynote)

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EUV lithography started to employ as manufacturing (HVM) technology of 7-nm-node-logic devices for smart phones from 2019, and it started to use in HVM of 5-nm-node logic devices in 2020. However, it still has critical issues toward HVM in 5-nm node and beyond.

From 1995, the research and development (R&D) program of EUV lithography started at NewSUBARU [1] synchrotron light facility of Laboratory of Advanced Science and Technology for Industry (LASTI), Himeji Institute of Technology (present University of Hyogo). The first collaboration work started between HIT, Nikon, and Hitachi Central Research Lab. in 1996 to develop full exposure EUV tool which was called "ETS-1". Using this tool, 60 nm L/S pattern replication is demonstrated in a large area size. After that, ASET program, four national project such as Selete, EUVA, and EIDEC were carried out in Japan, and each project period was five years. In these programs, the fundamental R&D of EUV resist, EUV mask, EUV optics, and EUV light source were carried out at NewSUBARU, LASTI. And we involved in these three projects for the R&D of EUV resist, EUV mask, and EUV optics. And we also have collaborated with many private companies, universities, and research institutes in the world.

The key points of R&D activities of EUV resist, EUV mask, and EUV optics are introduced. In addition, it is discussed that the lithographic potential extension of EUVL to shorter exposure wavelength.

References

[1] T. Watanabe, H. Kinoshita, H. Nii, Y. Li, K. Hamamoto, T. Oshinio, K. Sugisaki, K. Murakami, S. Irie, S. Shirayone, Y. Gomei, and S. Okazaki, "Development of the large field extreme ultraviolet lithography camera," *J. Vac. Sci. Technol.,* B**18** (2000) 2905-2910.
[2] T. Watanabe, H. Kinoshita, K. Hamamoto, M. Hosoya, T. Shoki, H. Hada, H. Komano, and S. Okazaki, "Fine pattern replication using ETS-1 three-aspherical mirror imaging system," *Jpn, J. Appl. Phys.,* **41** (2002) pp.4105-4110.

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Takeo Watanabe received his Ph.D. from Osaka City University in 1990. He is Full Professor, Director of Center for EUV, and Dean Laboratory of Advanced Science and Technology for Industry, University of Hyogo. He is an expert of the EUV lithographic technology, including optics, exposure tool, mask and resist related technologies. He has authored over 250 technical papers, and he is international affair, and the organizing and program committee members, of the International Conference of Photopolymer Science and Technology (ICPST). He is also Conference Chair of the International Conference of Photomask Japan. And he is a program committee member of the International Conference on Electron, Ion, and Photon Beam Technology and Nanofabrication (EIPBN).