DOI: 10.34854/ICPAF.52.2025.1.1.007

PROBLEMS AND PROSPECTS OF DEVELOPMENT OF X-RAY LITHOGRAPHY *)

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The special place of lithography against the background of hundreds of technological operations and types of equipment used in the production of chips is due to the following. Firstly, the progress of lithography has practically become synonymous with the development of microelectronics, since it directly depends on the topological dimensions on the chip formed by lithography. Secondly, the equipment for lithography, as well as consumables, are the most expensive. So only a set of masks for the production of one chip can cost up to 10 million US dollars.

Until recently, the main type was immersion lithography at a wavelength of 193 nm. However, a longer wavelength limits the resolution to 65 nm. The use of various methods to increase the resolution made it possible to "draw" lines up to 8 nm wide [1]. However, their use dramatically increases the percentage of defects, reduces productivity several times, requires the use of unique and expensive resists, and increases the required number of masks. Therefore, such topological dimensions are not used in real chips. Usually, immersion lithography is used from 16 nm and more.

The lithography process returns to the classic sequence: deposition, exposure and development of the resist - with the transition to the extreme ultraviolet (EUV) or X-ray range. Currently, ASML, the Netherlands is the only manufacturer of EUV lithographs with an operating wavelength of 13.5 nm. The choice of this wavelength is due to the presence of highly reflective Mo / Si multilayer mirrors and the maximum emission of highly charged tin ions at this wavelength. The tin target is excited by pulsed radiation of a CO_2 laser with an average power exceeding 20 kW. Due to the better spatial resolution in modern chips, layers with minimal topological dimensions are made using this technology.

The development of an in-house X-ray lithograph requires the possession of a number of critical technologies. The report will provide an overview of these technologies. Particular attention will be paid to the existing and promising sources of EUV / X-ray radiation for lithography and related technologies. The problems and prospects for the development of this technology for the coming years are discussed. A new concept of X-ray lithography is reported, developed at the Institute of Physics of Microstructures of the Russian Academy of Sciences, in collaboration with the IAP RAS [2]. The rationale for the advantages and feasibility of lithography at a new wavelength of 11.2 nm is provided. A brief overview of the domestic level of development of critical technologies is given, and the Roadmap for the Development of X-ray Lithography in the Russian Federation is discussed.

References

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*) abstracts of this report in Russian