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EXTREME ULTRAVIOLET LITHOGRAPHY PROJECTION SYSTEM DESIGN BASED ON GROUPING AND GRAPHICAL USER INTERFACE

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Introduction. The projection system for extreme ultraviolet lithography directly influences whether lithography can be implemented. At present, the projection system for extreme ultraviolet lithography is mostly designed with six-sided mirrors, using high-order aspherical surfaces or freeform surfaces, which have higher requirements for processing and inspection. For the initial structure of the 6-mirror projection system, there are various grouping design methods. We analysis the initial structure obtained by group design based on the design parameters of the extreme ultraviolet lithography projection optical system. The parameters are calculated using MATLAB and the initial structure of the projection system is obtained by ZEMAX or CODE V.

Main part. The projection system is an important part of the optical system for EUV lithography, which needs to ensure high image quality and resolution. For the EUV lithography optical system in the illumination system, mask, projection system are used reflective design. Most of the projection systems are designed to use an even number of mirrors, and currently known extreme ultraviolet projection objectives are grouped according to the number of mirrors, such as 2 mirrors, 4 mirrors, 6 mirrors, 8 mirrors and 10 mirrors [1]. There are also references in some papers to designs with an odd number of mirrors, such as a projection system with 5 mirrors [2]. Usually when the number of components in the system is large, it is better to use the group design. For six-mirror system, the most intuitive way is to divide them into two sub systems based on the intermediate image (IMI), with the most common grouping being the front group consisting of M1, M2, M3 and M4, and the rear group consisting of two mirrors, M5 and M6[3]. There are 4 mirrors in the first group, which is difficult to reduce the number of structural variants. And there is no significant reduction in construction difficulty, which seriously reduces the efficiency and success rate of structure generation. Therefore, we divided the first group into two more groups. For now, we have three groups which make it easier to calculate and determine the position of the pupil. According to primary design specifications of projection system for manufacture [4]. We can calculate parameters such as the radius of the system. The calculation process is visualized to be informed more intuitively and in real time about the state and performance of the initial structure. Each parameter is calculated by MATLAB, and then the parameters are used to construct a visualization interface using the MATLAB GUI and the initial structure of EUVL projection system obtained by ZEMAX or CODE V. By moving the slider, the values of the variants and the state of the structure can be updated, thus intuitively showing whether the system structure is reasonable or not.

Conclusion. The calculation of the initial structure of each subsystem of the EUV

projection system was realized by the group design method using the basic theory of geometrical optics. Based on that, the visualization of the initial structure construction of the projection system was completed to improve design efficiency.

List of sources used:

1. Mann H J, Ulrich W. Reflective high-NA projection lenses[C]//Optical Design and Engineering II. SPIE, 2005, 5962: 332-339.

2. Dinger U. Microlithography projection objective and projection exposure apparatus: U.S. Patent 6,495,839[P]. 2002-12-17.

3. Erdmann A, Fühner T, Evanschitzky P, et al. Optical and EUV projection lithography: A computational view[J]. Microelectronic Engineering, 2015, 132: 21-34.

4. Cao Z, Li Y, Liu F. Designing projection objectives for 11-nm node of extreme ultraviolet lithography[J]. Journal of Micro/Nanolithography, MEMS, and MOEMS, 2014, 13(3): 033014-033014.