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OFFNER RELAY SYSTEM FOR EUV LITHOGRAPHY ILLUMINATION

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Introduction. For extreme ultraviolet lithography optical system, the illumination system is one of the important parts. The illumination system can uniformize the extreme ultraviolet light which is collected by the collector mirror and provides uniform illumination for the mask and projection system. In this article, an Offner relay system is attempted to be used as an illumination system for EUV lithography, and the current influencing factors, feasibility, and next optimization methods are discussed.

Main part. Commercial extreme ultraviolet lithography illumination systems use two compound eyes and a relay system, which allows for multiple illumination modes. This structure is difficult to process and mount. Therefore, it is desired to design an illumination system for EUV lithography using the Offner-relay system.
The classical Offner relay consists of two reflective concentric surfaces: a concave primary mirror (M1), and a secondary convex mirror (M2, the aperture stop). Rays are launched from object points behind the convex surface. Petzval, coma, distortion, chromatic aberration, and spherical aberration all equal to 0. Just remind high-order astigmatism. The basic Offner relay system design is limited by higher-order astigmatism and can be shown to be related to spherical aberration of the chief ray. That can be corrected with a meniscus shell or prism, but for EUV, only reflector can be used. For NA=0.33, the classical Offner relay system still has large aberration, if NA< 0.1, the system will have good image quality. However, this does not satisfy the system design requirements. We will try to optimize this system using aspherical and freeform surfaces. Then we will analyze the parameters such as aberration. It also discusses how to choose a compensation system to solve the problem of aberration caused by mirror tilt, defocus, off-axis, etc. If necessary, M1 and M3 can be optimized as a generalized Offner relay system by considering different radii. Although it leads to some machining complexity, this might reduce the aberration.

Conclusion. Because of the special characteristics of the extreme ultraviolet wavelength, only reflective systems can be used. As a result, many aberration correction and compensation systems cannot be used here. Optimize the Offner relay system by using aspherical, freeform surfaces or reflective compensation systems. Analyze its feasibility as an extreme ultraviolet lithography illumination system.

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