To search page

2000s
ArF immersion scanner
~ Discrete Semiconductor/Others ~

The KrF excimer laser step-and-scan exposure system used in the 1990s was replaced by an ArF excimer laser exposure system with a wavelength of 193 nm in the 2000s. In parallel with this, the development of F2 excimer laser was promoted for next-generation exposure system. Since the resolution (R) of the exposure system depends on the wavelength and NA ($R \propto \lambda/NA$). The aim was to shorten the wavelength λ of the light source to 157 nm of F2 laser. However, the development of optical systems, masks, pellicles, and resist materials was difficult. TSMC proposed an immersion lithography system using ArF light at SPIE in 2002 (1), and Nikon also proposed the ArF lithography system as a leading candidate for the next generation at International Symposium of 157nm Lithography in the same year. (2). As a result, the development activities of the industry quickly shifted to ArF immersion lithography systems.

The NA is $n \cdot \sin\theta$ (θ; the opening angle of the lens that forms an image on the wafer surface), and the conventional NA cannot exceed 1 as far as the medium between the lens and the wafer is air (refractive index n=1), but the NA can be increased to more than 1 if the refractive index is greater than 1. The idea of applying the immersion method to exposure systems had been around since 1980. In 1998, Nikon proposed the system called the Local Fill method, in which the immersion liquid was held only between the exposure area and the lens (3). In 2001, MIT proposed the use of pure water as the immersion liquid (4). Immersion exposure systems were considered to have entered the practical stage.

ASML started to deliver a prototype immersion scanner (1150i) in 2003, and commercialized the TWINSCAN XT: 1250i in 2004. It was called TWINSCAN. The system performed positioning and focus adjustment in a dry state and exposed the image in liquid immersion. The TWINSCAN XT: 1700i NA1.20 with NA=1.2 was released during 2006. In 2007, the TWINSCAN XT: 1700i NA1.35 with NA=1.35 was released, and ArF immersion scanners came into wide use.

References:

【1】B.J. Lin “Semiconductor Foundry, Lithography, and Partners”, Proc. SPIE 4688, (2002)
【2】S. Owa et al. “Nikon F2 Exposure Tool” 3rd International Symposium of 157nm Lithography,(2002)
【3】Y. Fukami and N. Magome, “Projection exposure method and System” International Patent Application WO99/49504 (1999)
【4】Switkes M. and Rothschild M. “Immersion Lithography at 157nm” J. Vac. Sci. Technol. B , Vol.19,

No.6, P. 2353, (2001)

Version 2022/6/12