

## Early 1990s

### i-line reduction-projection exposure system

~ Discrete Semiconductor/Others ~

The g-line reduction- projection exposure (stepper) system became the standard for lithography in the 1.3  $\mu\text{m}$  generation<sup>(1)</sup>. Since the resolution (R) of the stepper depended on the wavelength and NA ( $R \propto \lambda / \text{NA}$ ), it was necessary to shorten the wavelength of the light source or increase the NA of the lens for lithography in the submicron region. The i-line (spectral line: 365 nm), which had a shorter wavelength than the g-line (spectral line: 436 nm), was used as a light source. In 1986, GCA commercialized an i-line stepper (NA=0.35) that resolves 0.7 $\mu\text{m}$  (8500DSW). Nikon had developed an i-line stepper (NSR-1010i3) with a resolution of 0.8 $\mu\text{m}$  in 1984. However, there was still no photoresist with high sensitivity for i-line, and Nikon and Canon tried to achieve high NA with g-line for 0.8 $\mu\text{m}$ . In the 0.8 $\mu\text{m}$  generation, g-line steppers became the mainstream.

Photoresist for i-line was developed by NAGASE at the end of the 1980s, and the development of reduction- projection exposure (stepper) of i-line began for the 0.5  $\mu\text{m}$  process in the 1990s. Nikon launched an i-line stepper (NA=0.5) with a resolution of 0.5  $\mu\text{m}$  (NSR-1755i7) in 1990. (Figure 1) Canon also developed the i-line stepper (FPA-2000i1). The i-line stepper became a main equipment of the VLSI industry for fabricating the 16M DRAM generation products with 0.5 $\mu\text{m}$  process. The i-line stepper continued to be upgraded in NA, and the resolution was improved to 0.35  $\mu\text{m}$  by Nikon and Canon in 1996, and it was also used for the production of the 64M DRAM generation.



Figure 1 i-line stepper (NSR-1755i7)  
(Courtesy of NIKON CORPORATION)

References:

【1】 Semiconductor Museum of Japan, Process Technology, “Early 1980s: Advancing miniaturization requires the use of steppers in lithography”

<http://www.shmj.or.jp/english/pdf/process/exhibi422E.pdf>

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