Gigabit 반도체 광미세가공용 감광재료의 발전과 전망
Progress of Photoresist Materials for Gigabit IC Photolithography

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Photoresist materials play the quintessential role in advancing optical lithography to overcome the Rayleigh diffraction limit, i.e. accomplishing high resolution below the irradiation wavelength. By combining advanced resist materials with high-NA optical scanners and resolution enhancement, it has been accomplished what seemed impossible only a few years ago: 200 nm resolution features using i-line (365 nm) and sub-100 nm contact holes using 248 nm KrF laser lithography. At 193 nm ArF laser, chemically amplified (CA) resist technology is poised to reveal 80 nm features and even finer dimensions at 157 nm F_2 laser, paving the path for many more device generations using optical lithography. Such progress undoubtedly will delay implementation of next generation lithography (NGL) alternatives such as extreme-UV (EUV) and EPL(SCALPEL) for an indeterminate period of time.

To achieve sub-wavelength lithography results, photoresist technology - like the phase shifting masks (PSMs), exposure scanner optics and inspection techniques - is pushed to its absolute limit. Most importantly, the fundamental structure of resists must change - from the well-known i-line's novolac-based photoresists to polyhydroxystyrene-based photoresists at 248 nm, to alicyclic polyolefin or polyacrylate-based resists at 193 nm lithography, to an as-yet-undetermined polymer family at 157 nm lithography. Advanced resists require much engineering ingenuity and extensive optimization of polymer chemistry, photo-acid generators (PAGs) and various additives as well as adequate photochemistry. Today, more than ever, integrated development efforts - taking simultaneous advantages of high-NA scanners, OPC, PSMs, anti-reflective coatings (ARCs) and advanced resist chemistries - are critical.

International Technology Roadmap for Semiconductors [ITRS]

Year	Achieved			Short term		Long term		
	1990	1995	1999	2002	2005	2008	2011	2014
DRAM(bits)	16M	256M	1G	4G	16G	64G		
Resolution (nm)	500	250	180	130	100	70	50	35
Lithography (wavelength, nm)	365 I-line	248 I/KrF	248 KrF	248/193 KrF+RET ArF	193/157 ArF+RET F_2	157/13 F_2+RET EPL EUV	13 EUV EPL IPL	13 EUV IPL EPL
Resist thickness (㎛)			0.5-0.7	0.4-0.5	0.3-0.4	0.21-0.28	0.15-0.20	0.11-0.14
Depth of focus (㎛)	1.5	1.0	0.6	0.5	0.4	0.3		

Optical lithography (λ, nm) : I-line (365), KrF (248), ArF (193), F_2 (157)
RET : resolution enhancement technology EUV : extreme ultraviolet (10-14㎚)
EPL : electron projection lithography IPL : ion projection lithography

Source : *Solid State Technology*, 29 (May 1999), 21 (Jan. 2000), 41 (March 2000).