

Etch Rates for Micromachining and IC Processing (Å/min)																	v. 4.4 29 July 1996	
U.C. Berkeley Microfabrication Laboratory / Berkeley Sensor & Actuator Center / Kirt R. Williams																		
The top etch rate was measured by the author with fresh solutions, clean chambers, etc.																		
The center and bottom values are the low and high etch rates observed by the author and others in the UCB Microfab using fresh and used solutions, clean and "dirty" chambers, etc.																		
ETCHANT EQUIPMENT CONDITIONS	TARGET MATERIAL	MATERIAL																
		SC Si <100>	Poly n <sup>+</sup>	Poly undop	Wet Ox	Dry Ox	LTO undop	PSG unanl	PSG annld	Stoic Nitrid	Low-σ Nitrid	Al/ 2% Si	Sput Tung	Sput Ti	Sput Ti/W	OCG 820PR	Olin HntPR	
Concentrated HF (49%) Wet Sink Room Temperature	Silicon oxides	-	0	-	23k 18k 23k	F	>14k	F	36k	140	52 30 52	42 0 42	<50	F	-	P 0	P 0	
10:1 HF Wet Sink Room Temperature	Silicon oxides	-	7	0	230	230	340	15k	4700	11	3	2500 2500 12k	0	11k	<70	0	0	
25:1 HF Wet Sink Room Temperature	Silicon oxides	-	0	0	97	95	150	W	1500	6	1	W	0	-	-	0	0	
5:1 BHF Wet Sink Room Temperature	Silicon oxides	-	9	2	1000 900 1080	1000	1200	6800	4400 3500 4400	9	4 3 4	1400	<20 0.25 20	F	1000	0	0	
Phosphoric Acid (85%) Heated Bath with Reflux 160°C	Silicon nitrides	-	7	-	0.7	0.8	<1	37	24 9 24	28 28 42	19 19 42	9800	-	-	-	550	390	
Silicon Etchant (126 HNO <sub>3</sub> : 60 H <sub>2</sub> O : 5 NH <sub>4</sub> F) Wet Sink Room Temperature	Silicon	1500	3100 1200 6000	1000	87	W	110	4000	1700	2	3	4000	130	3000	-	0	0	
KOH (1 KOH : 2 H <sub>2</sub> O by weight) Heated Stirred Bath 80°C	<100> Silicon	14k	>10k	F	77 41 77	-	94	W	380	0	0	F	0	-	-	F	F	
Aluminum Etchant Type A (16 H <sub>3</sub> PO <sub>4</sub> : 1 HNO <sub>3</sub> : 1 HAc : 2 H <sub>2</sub> O) Heated Bath 50°C	Aluminium	-	<10	<9	0	0	0	-	<10	0	2	6600 2600 6600	-	0	-	0	0	
Titanium Etchant (20 H <sub>2</sub> O : 1 H <sub>2</sub> O <sub>2</sub> : 1 HF) Wet Sink Room Temperature	Titanium	-	12	-	120	W	W	W	2100	8	4	W	0 0 <10	8800	-	0	0	
H <sub>2</sub> O <sub>2</sub> (30%) Wet Sink Room Temperature	Tungsten	-	0	0	0	0	0	0	0	0	0	<20	190 190 1000	0	60 60 150	<2	0	
Piranha (~50 H <sub>2</sub> SO <sub>4</sub> : 1 H <sub>2</sub> O <sub>2</sub> ) Heated Bath 120°C	Cleaning off metals and organics	-	0	0	0	0	0	-	0	0	0	1800	-	2400	-	F	F	
Acetone Wet Sink Room Temperature	Photoresist	-	0	0	0	0	0	-	0	0	0	0	-	0	-	>44k	>39k	
CF <sub>4</sub> +CHF <sub>3</sub> +He (90:30:120 sccm) Lam 590 Plasma 450W, 2.8T, gap=0.38cm, 13.56MHz	Silicon oxides	W	1900 1400 1900	2100 1500 2100	4700 2400 4800	W	4500	7300 3000 7300	6200 2500 7200	1800	1900	-	W	W	W	2200	2000	
CF <sub>4</sub> +CHF <sub>3</sub> +He (90:30:120 sccm) Lam 590 Plasma 850W, 2.8T, gap=0.38cm, 13.56MHz	Silicon oxides	W	2200 2200 2700	1700 1700 2100	6000 2500 7600	W	6400	7400 5500 7400	6700 5000 6700	4200 4000 6800	3800	-	W	W	W	2600 2600 6700	2900 2900 7200	
SF <sub>6</sub> +He (13:21 sccm) Technics PE II-A Plasma 100W, 250mT, gap=2.6cm, 50kHz sq. wave	Silicon nitrides	300 300 1000	730 730 800	670 670 760	310	350	370	610	480 230 480	820	620 550 800	-	W	W	W	690 690 830	630	
CF <sub>4</sub> +CHF <sub>3</sub> +He (10:5:10 sccm) Technics PE II-A Plasma 200W, 250mT, gap=2.6cm, 50kHz sq. wave	Silicon nitrides	1100	1900	W	730	710	730	W	900	1300	1100	-	W	W	W	690	600	
SF <sub>6</sub> +He (175:50 sccm) Lam 480 Plasma 150W, 375mT, gap=1.35cm, 13.56MHz	Thin silicon nitrides	W	6400	7000 2000 7000	300 220 400	W	280	530	540	1300	870	-	W	W	W	1500 1300 1500	1400	
SF <sub>6</sub> +He (175:50 sccm) Lam 480 Plasma 250W, 375mT, gap=1.35cm, 13.56MHz	Thick silicon nitrides	W	8400	9200	800	W	770	1500	1200	2800 2100 4200	2100	-	W	W	W	3400 3100 3400	3100	
SF <sub>6</sub> (25 sccm) Tegal Inline Plasma 701 125W, 200mT, 40°C	Thin silicon nitrides	W	1700	2800	1100 1100 1600	W	1100	1400	1400	2800 2800 2800	2300	-	W	W	W	3400 2900 3400	3100	
CF <sub>4</sub> +CHF <sub>3</sub> +He (45:15:60 sccm) Tegal Inline Plasma 701 100W, 300mT, 13.56MHz	Si-rich silicon nitrides	W	350	360	320	W	320	530	450	760	600	-	W	W	W	400	360	
Cl <sub>2</sub> +He (180:400 sccm) Lam Rainbow 4420 Plasma 275W, 425mT, 40°C, gap=0.80cm, 13.56MHz	Silicon	W	5700 5000 5000	3200 3400 6300	8 8 380	-	60	230	140	560	530	W	W	-	-	3000 2400 3000	2700	
HBr+Cl <sub>2</sub> (70:70 sccm) Lam Rainbow 4420 Plasma 200W, 300mT, 40°C, gap=0.80cm, 13.56MHz	Silicon	W	450 450 740	460	4 4 10	-	0	0	0	870	26	W	W	-	-	350 350 500	300	
Cl <sub>2</sub> +BCl <sub>3</sub> +CHCl <sub>3</sub> +N <sub>2</sub> (30:50:20:50 sccm) Lam 690 RIE 250W, 250mT, 60°C, 13.56MHz	Aluminum	W	4500	W	680	670	750	W	740	930	860	6000 1900 6400	W	-	-	6300 3700 6300	6300	
SF <sub>6</sub> (80 sccm) Tegal Inline Plasma 701 200W, 150mT, 40°C, 13.56MHz	Tungsten	W	5800	5400	1200 2000 2000	W	1200	1800	1500	2600	2300 1900 2300	-	2800 2800 4000	W	W	2400 2400 4000	2400	
O <sub>2</sub> (51 sccm) Technics PE II-A Plasma 50W, 300mT, gap=2.6cm, 50kHz sq. wave	Descumming photoresist	-	0	0	0	0	0	0	0	0	0	0	0	0	-	350	300	
O <sub>2</sub> (51 sccm) Technics PE II-A Plasma 400W, 300mT, gap=2.6cm, 50kHz sq. wave	Ashing Photoresist	-	0	0	0	0	0	0	0	0	0	0	0	0	-	3400	3600	
HF Vapor 1 cm over plastic dish Room temperature and pressure	Silicon oxides	-	0	0	660	W	780	2100	1500	10	19	A	0	A	-	P 0	P 0	
XeF <sub>2</sub> Simple custom vacuum chamber Room temperature, 2.6 Torr	Silicon	4600 2900 100k	1900 1100 2500	1800 1100 2300	0	-	0	0	0	120	2	0	800 440 1000	290 50 380	-	0	0	

Notation: - =test not performed; W=not performed, but known to Work ( $\geq 100 \text{ Å/min}$ ); F=not performed, but known to be Fast ( $\geq 10 \text{ kÅ/min}$ ); P=some of film Peeled during etch or when rinsed; A=film was visibly Attacked and roughened.

Rates measured are rounded to two significant figures.

Etch areas are all of a 4-inch wafer for the transparent films and half of the wafer for single-crystal silicon and the metals.

Etch rates will vary with temperature and prior use of solution or plasma chamber, area of exposure of film, other materials present (e.g., photoresist), film impurities and microstructure, etc. *Some variation should be expected.*