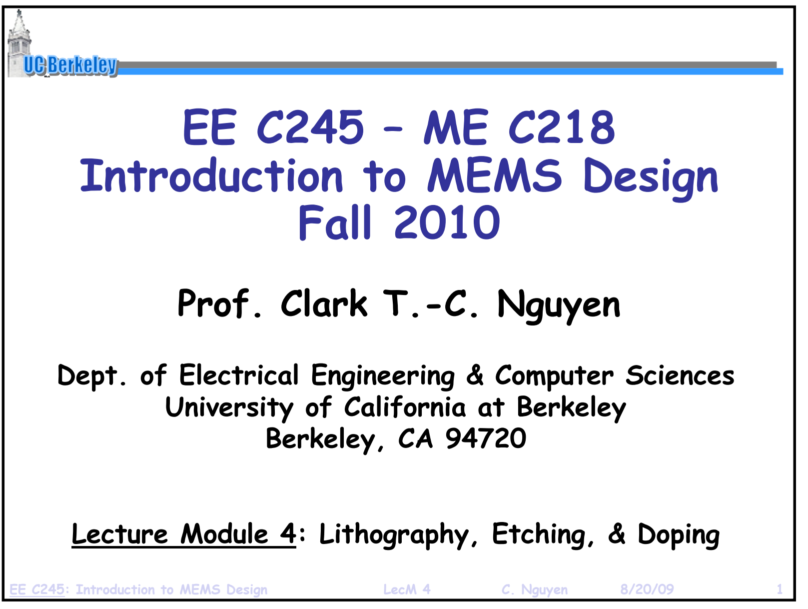
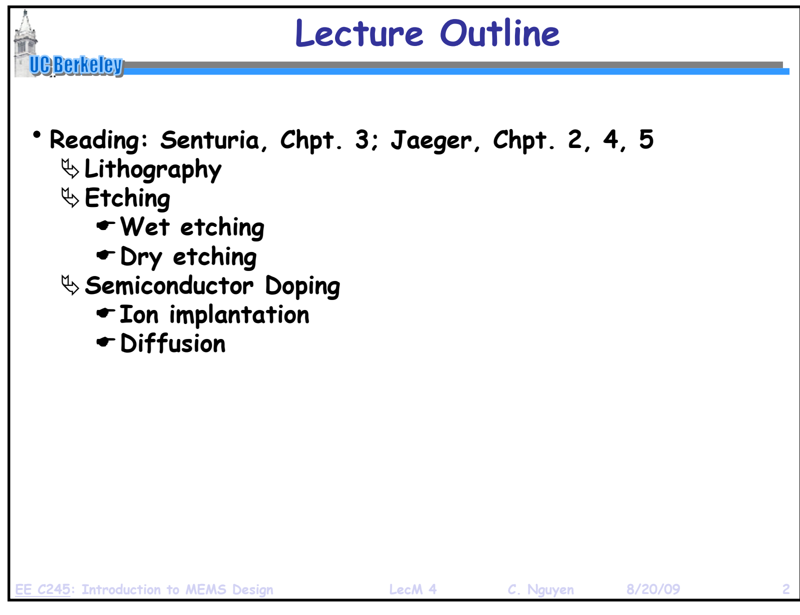
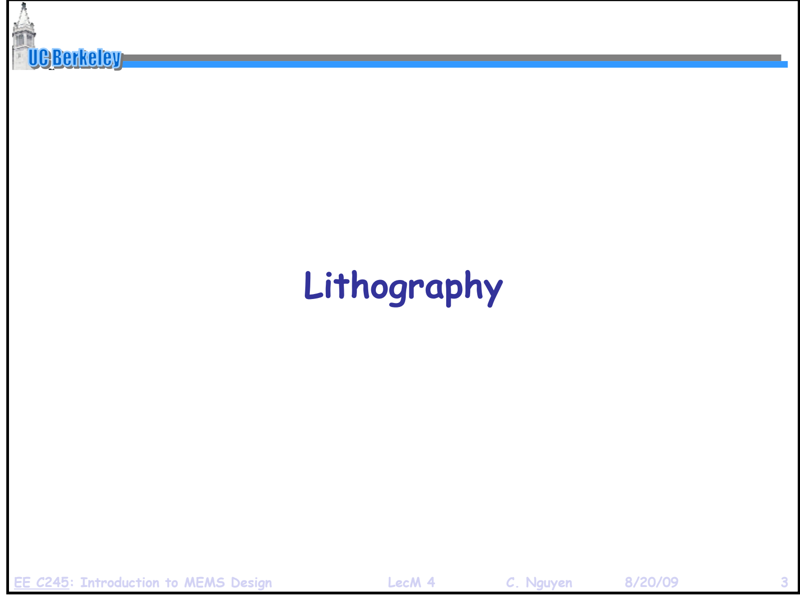
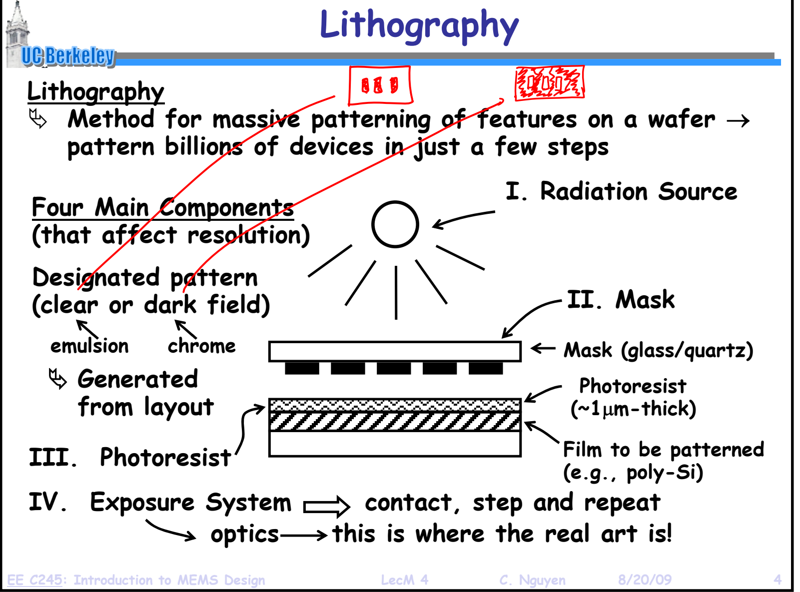
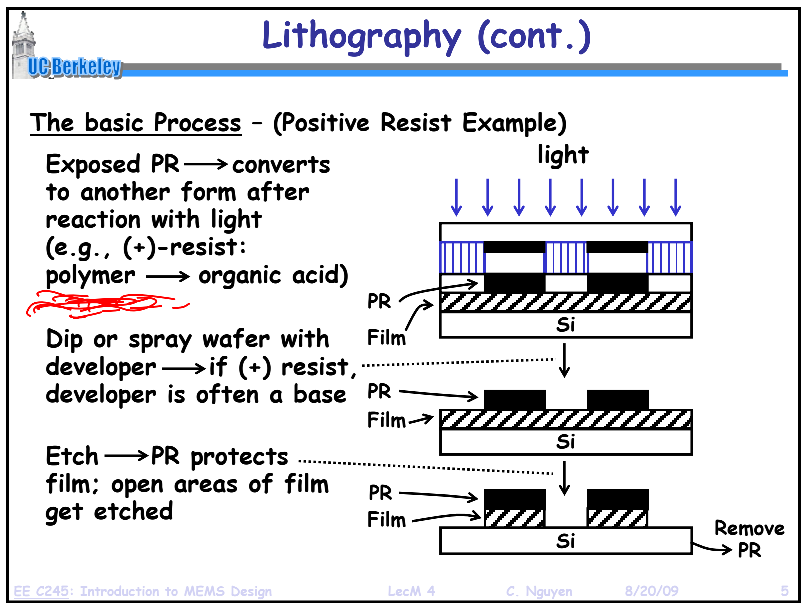


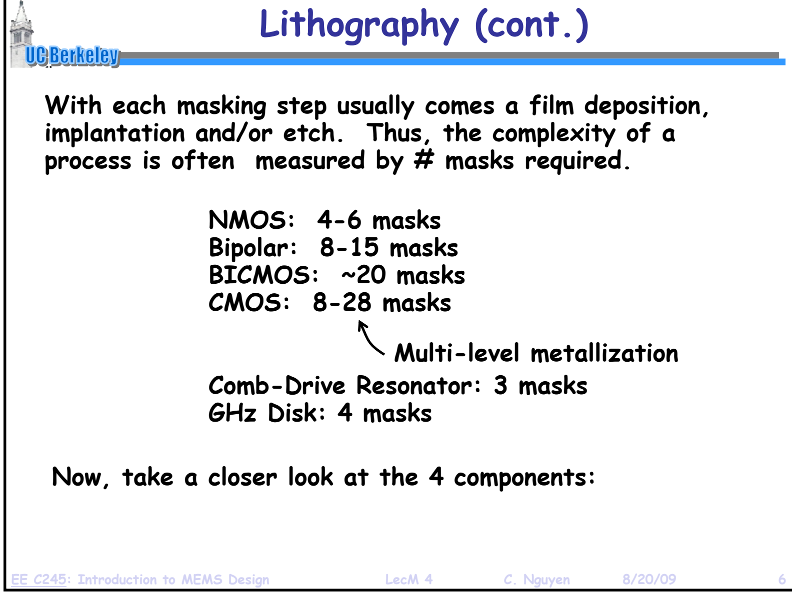


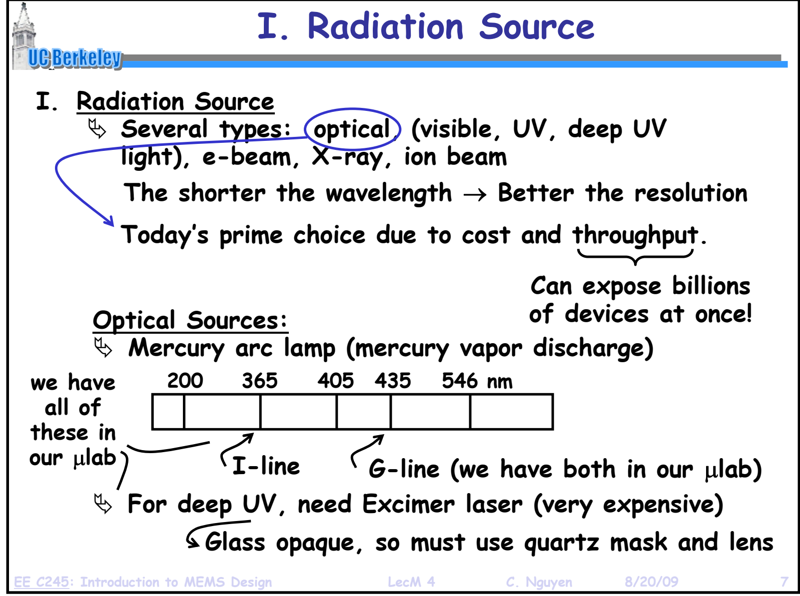


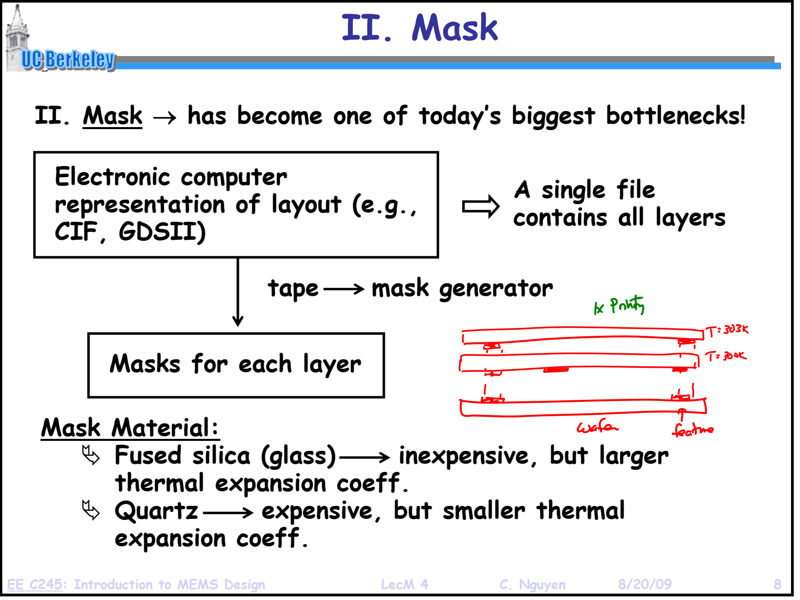


Copyright @ 2010 Regents of the University of California

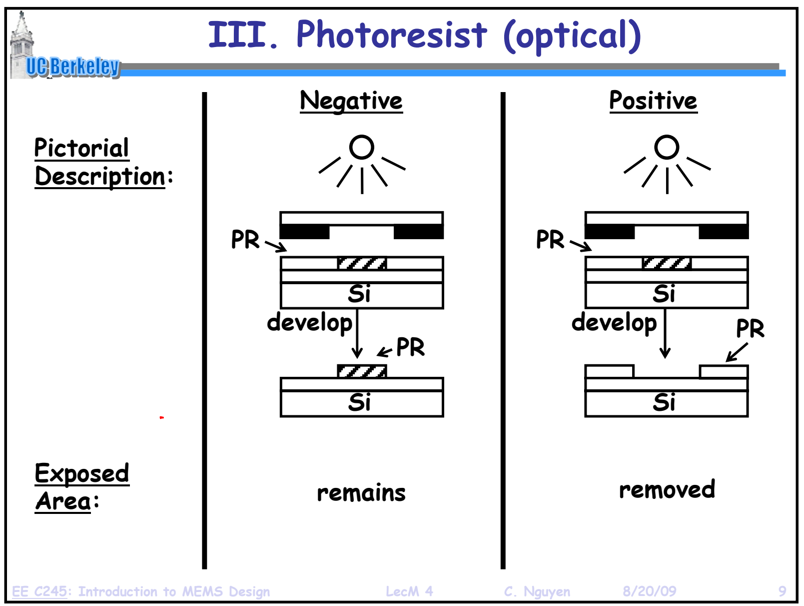


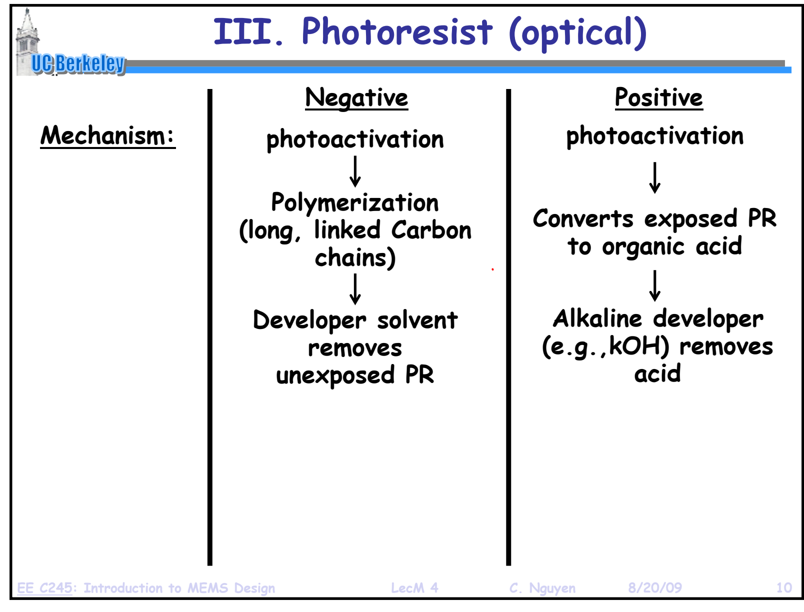


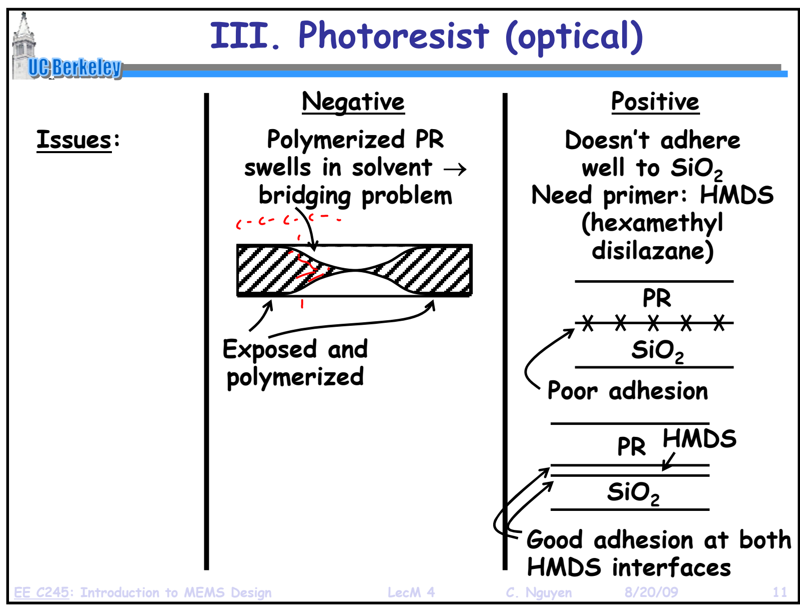


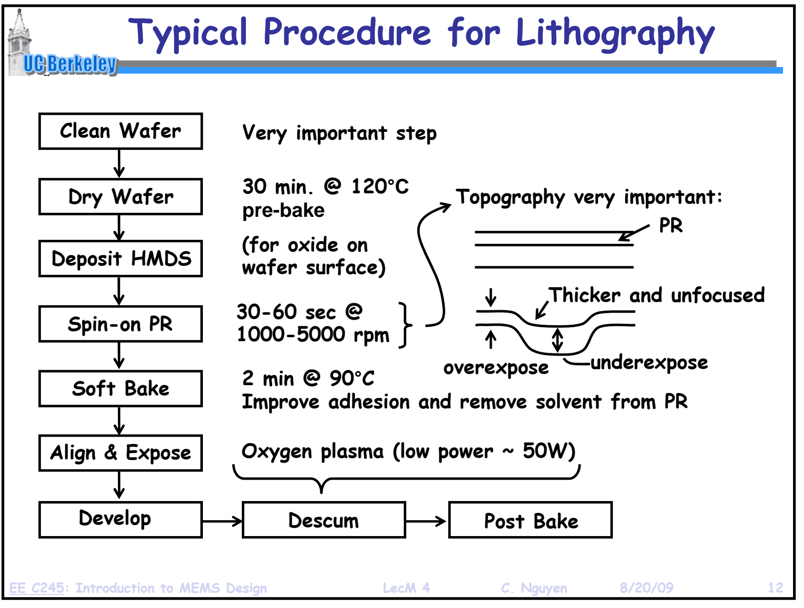


Copyright @ 2010 Regents of the University of California

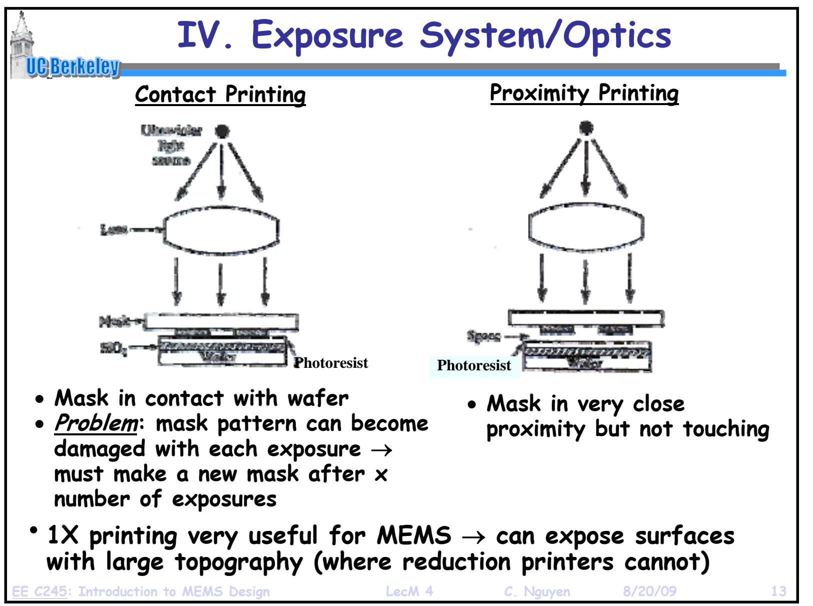


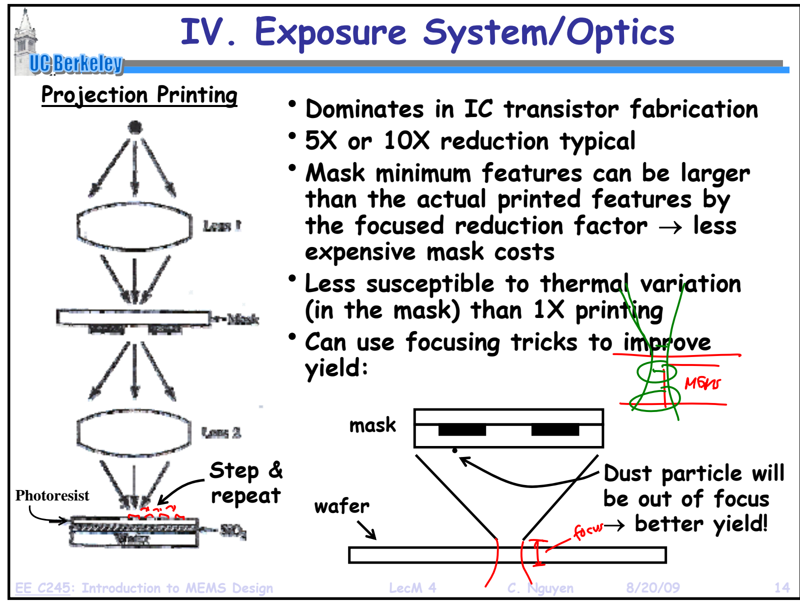


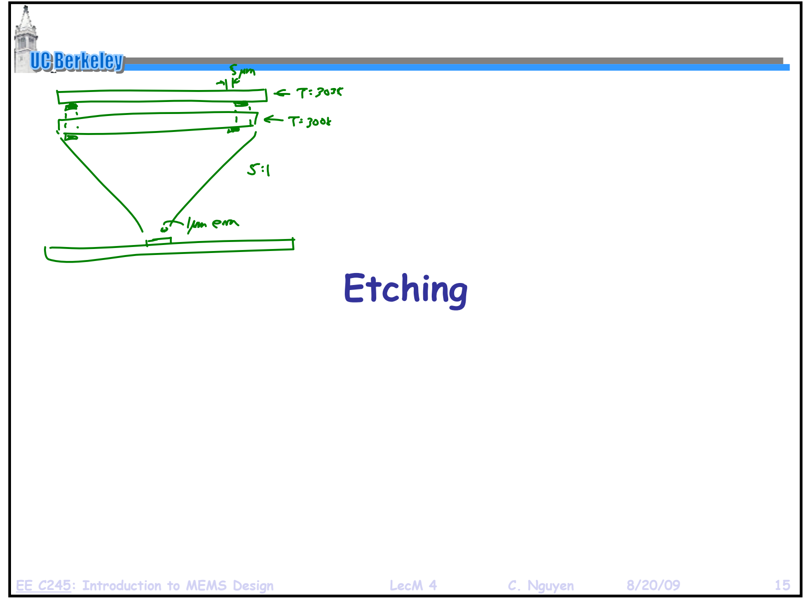


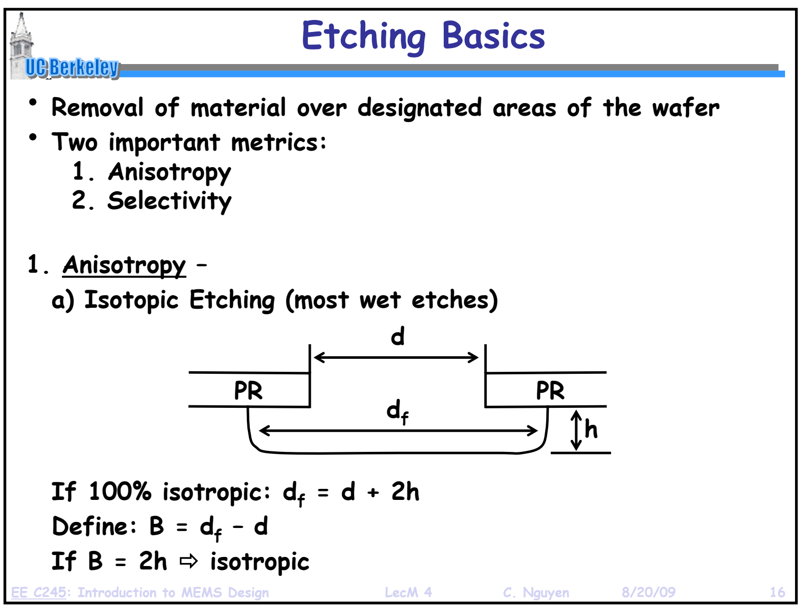


Copyright @ 2010 Regents of the University of California

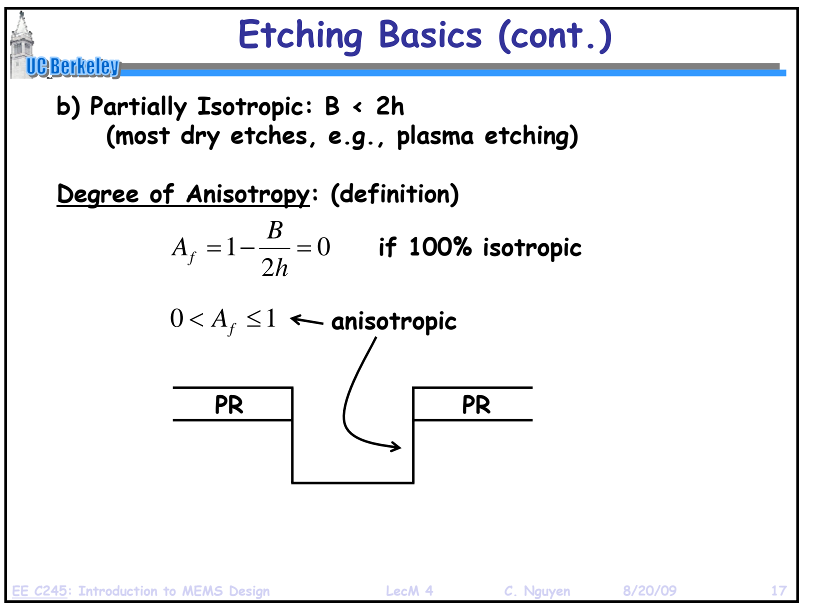


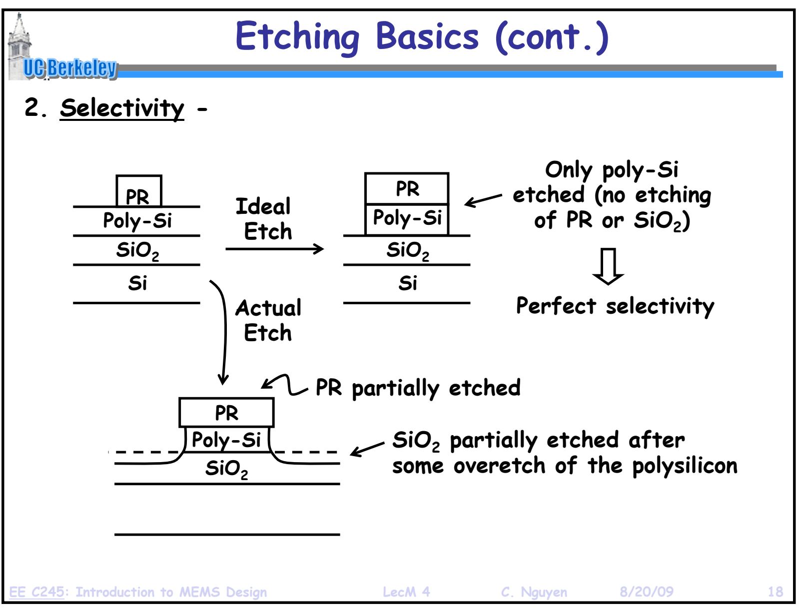


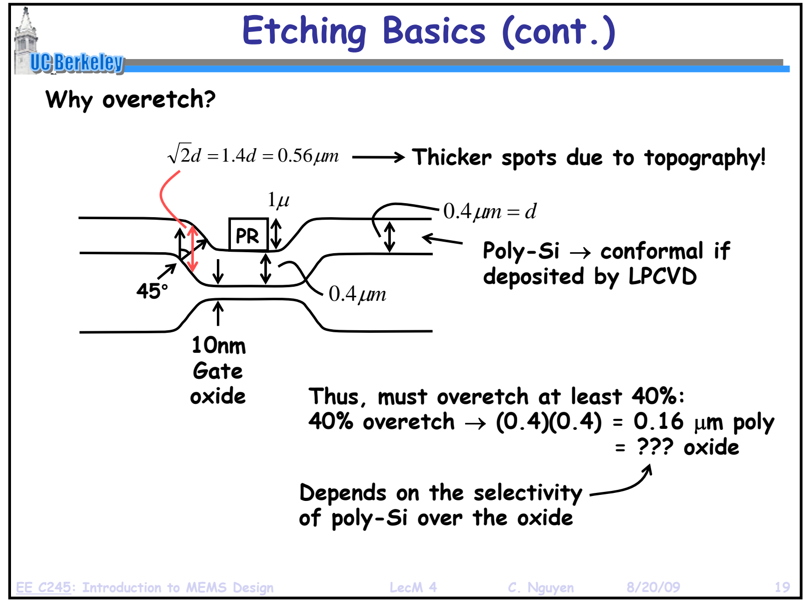


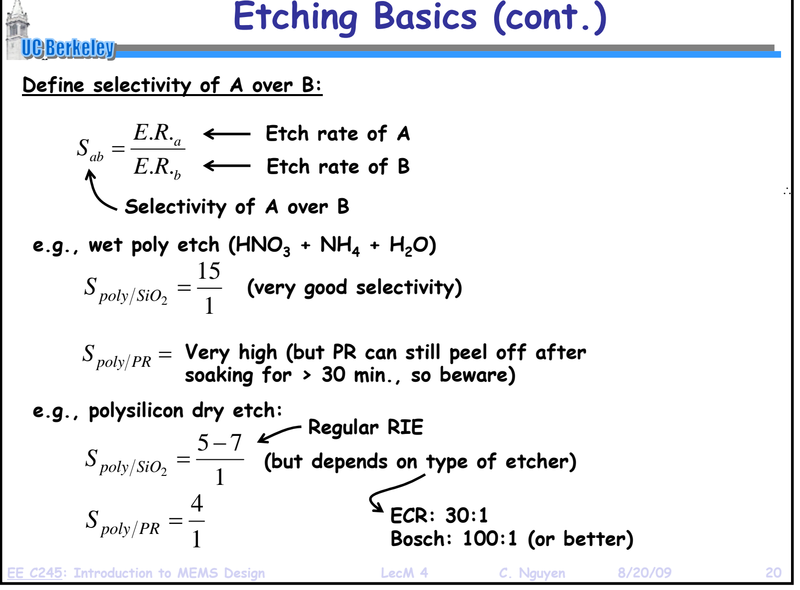


Copyright @ 2010 Regents of the University of California

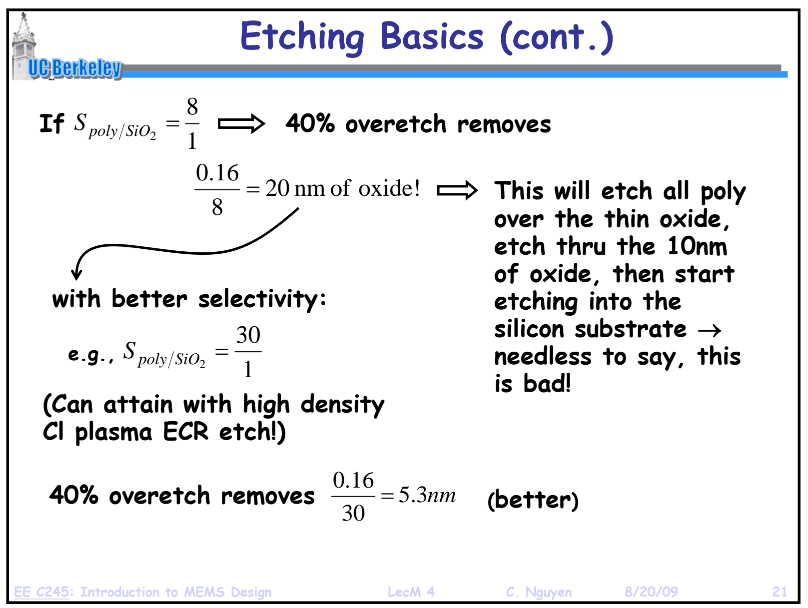


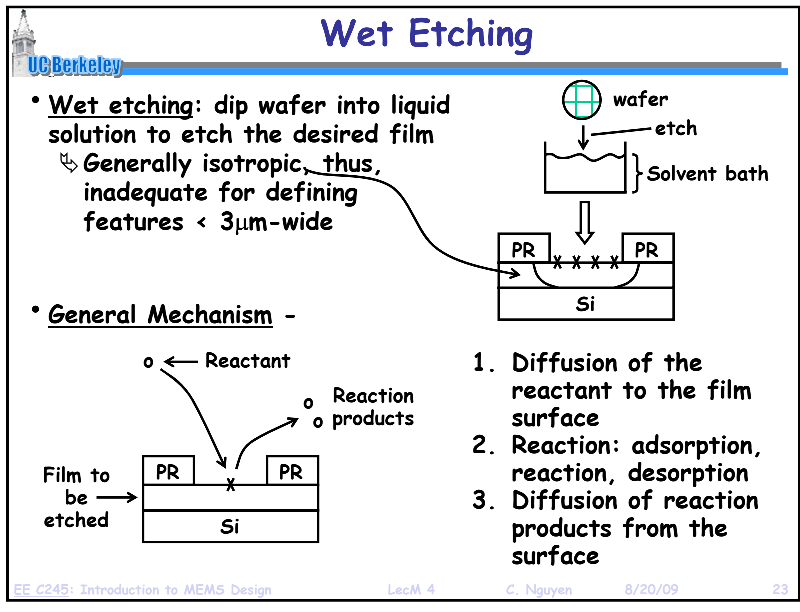


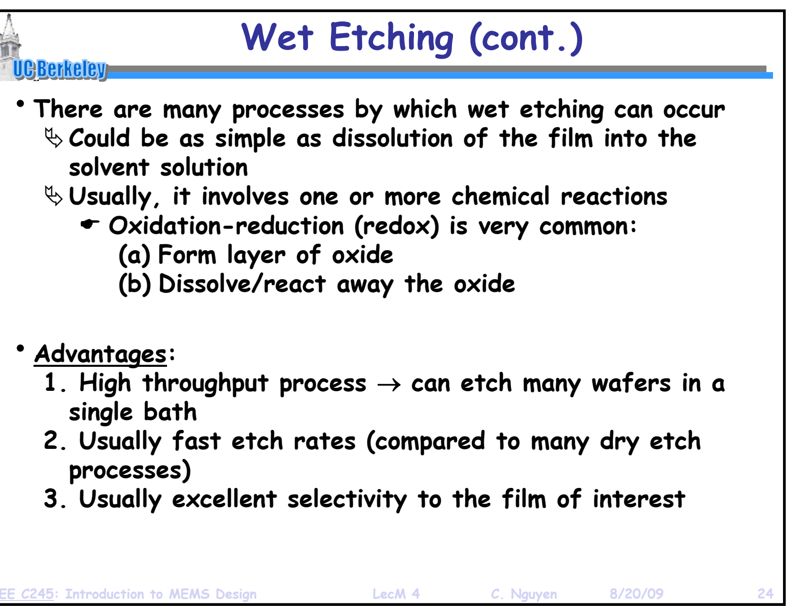




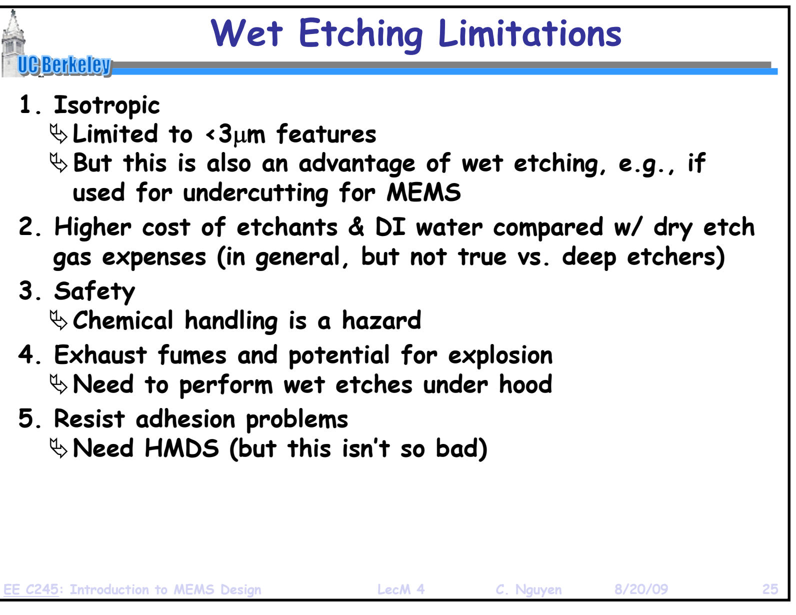
Copyright @ 2010 Regents of the University of California

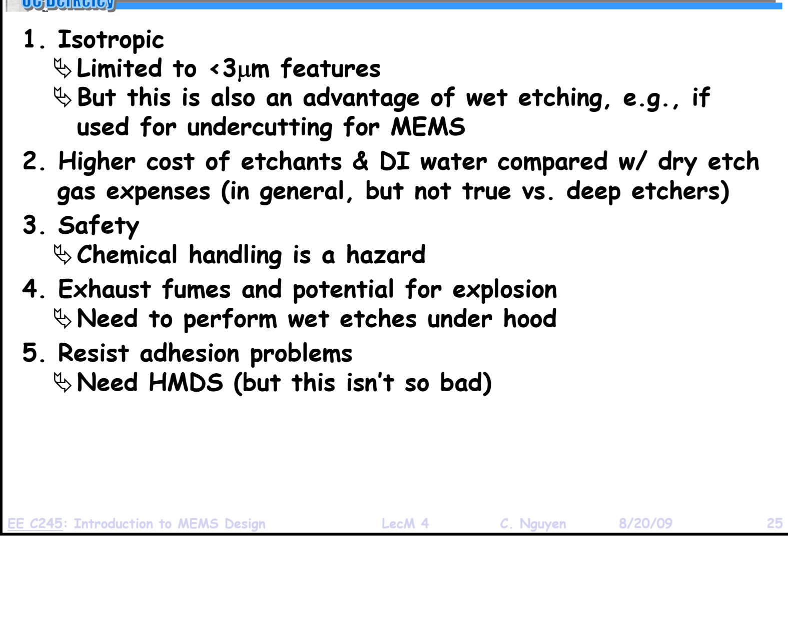


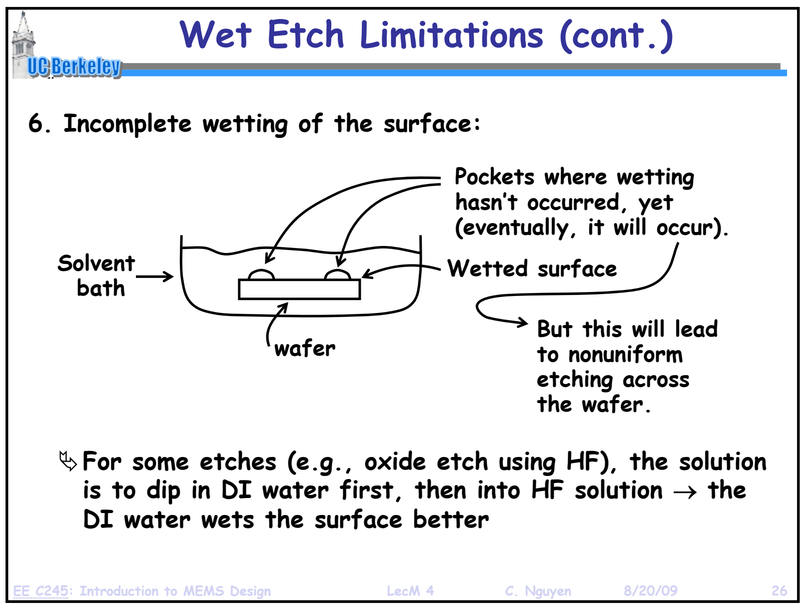


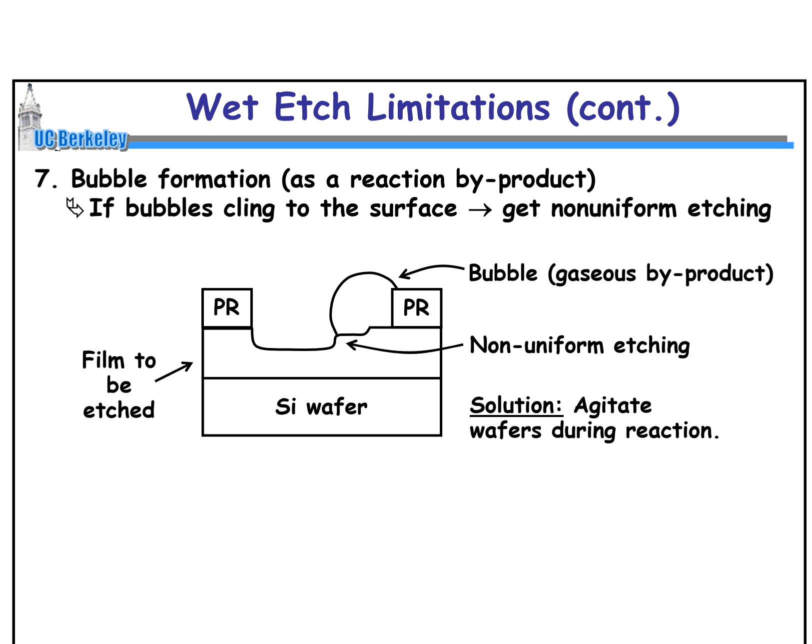


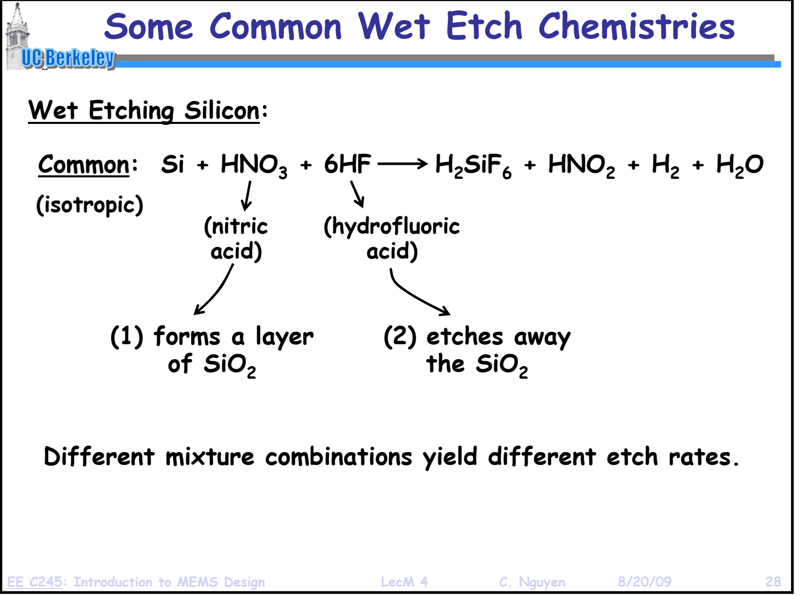
Copyright @ 2010 Regents of the University of California



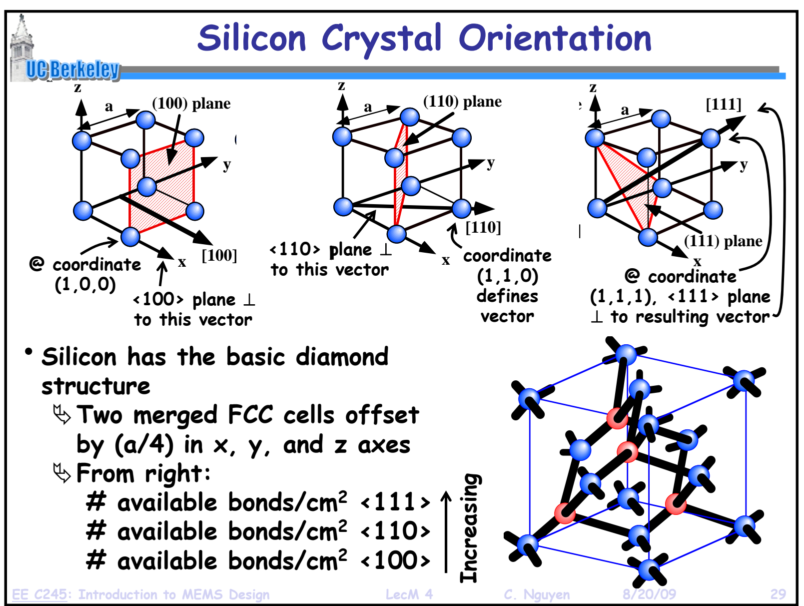


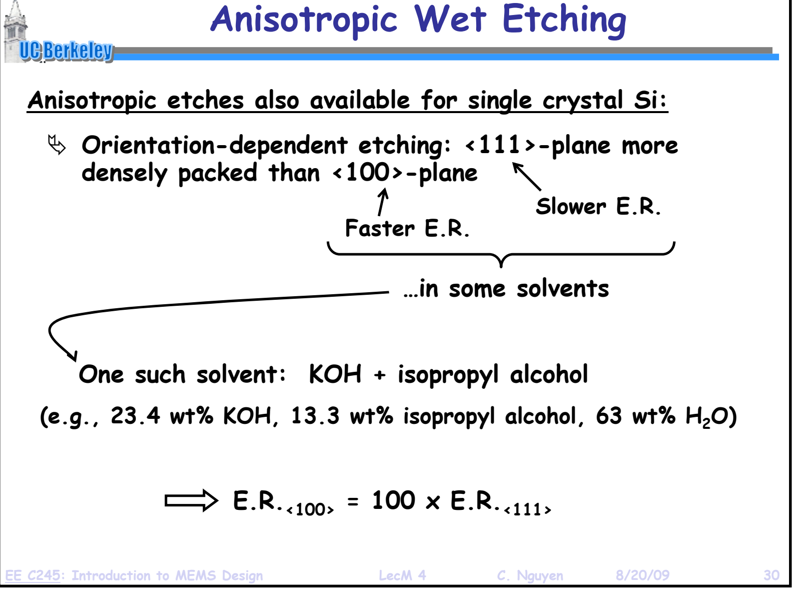


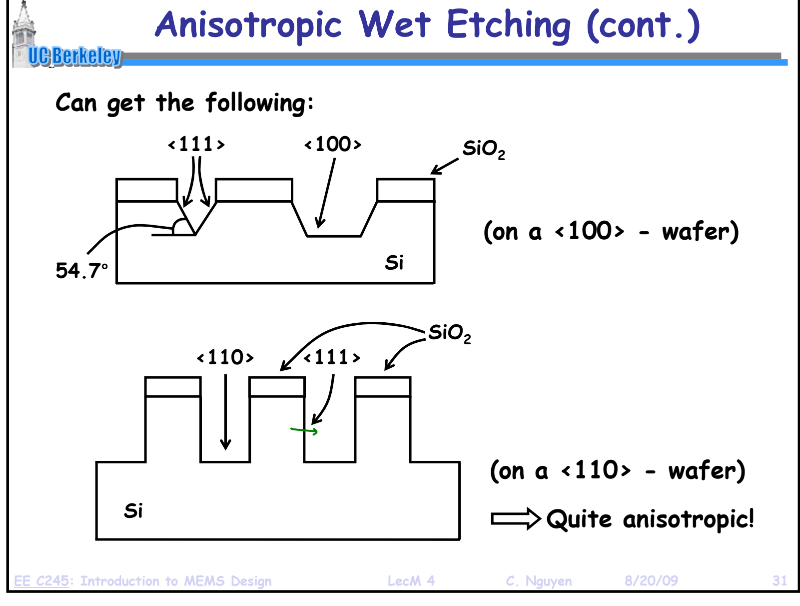


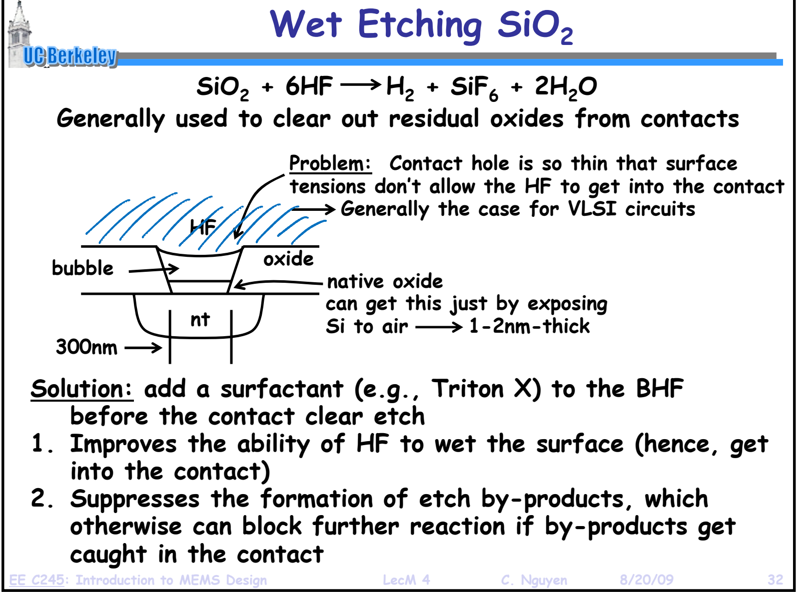


Copyright @ 2010 Regents of the University of California

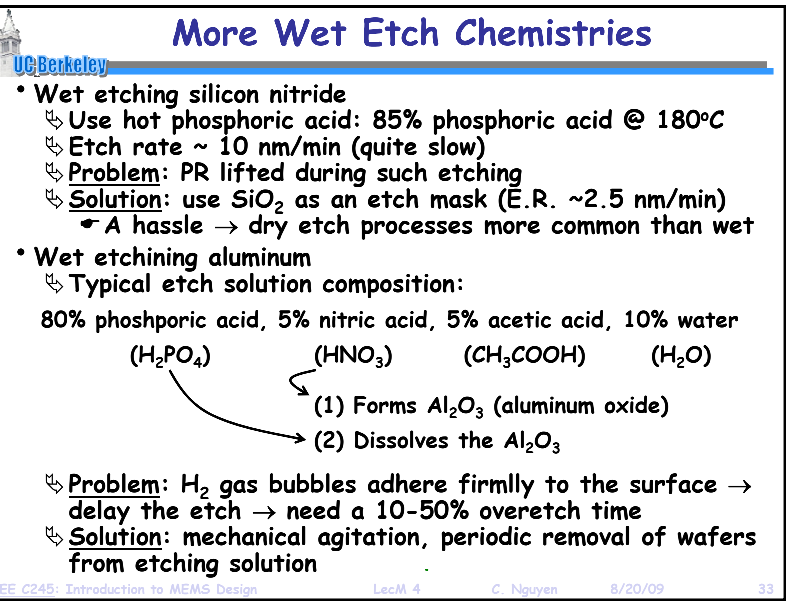








Copyright @ 2010 Regents of the University of California



Wet Etch Rates (f/ K. Williams)

UC Berkeley

Wet-Etch Rates for Micromachining and IC Processing (Å/min)

The top etch rate was measured by the authors with fresh solutions, etc. The center and bottom values are the low and high etch rates observed by the authors and others in our lab under less carefully controlled conditions.

ETCHANT EQUIPMENT CONDITIONS	TARGET MATERIAL	SC Si <100>	Poly n+	Poly undop	Wet Ox	Dry Ox	LTO undop	PSG unannl	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_3 : 60 H_2O : 5 NH_4F) 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_2O 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_3PO_4 : 1 HNO_3 : 1 HAc : 2 H_2O) Heated Bath 50°C	Aluminum	-	<10	<9	0	0	0	-	<10	0	2	6600 2600 6600	-	0	-	0	0
Titanium Etchant (20 H_2O : 1 H_2O_2 : 1 HF) Wet Sink Room Temperature	Titanium	-	12	-	120	W	W	W	2100	8	4	W	0 0 <10	8800	-	0	0
H_2O_2 (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_2SO_4 : 1 H_2O_2) 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

Notation: - =test not performed; W=not performed, but known to Work (≥ 100 Å/min); F=not performed, but known to be *Fast* (≥ 10 kÅ/min); P=some of film *Peeled* during etch or when rinsed; A=film was visibly *Attacked* and roughened.
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.
Each rates will vary with temperature and prior use of solution, area of exposure of film, other materials present (e.g., photoresist), film impurities and microstructure, etc. *Some variation should be expected.*

EE C245: Introduction to MEMS Design LecM 4 C. Nguyen 8/20/09 34

Film Etch Chemistries

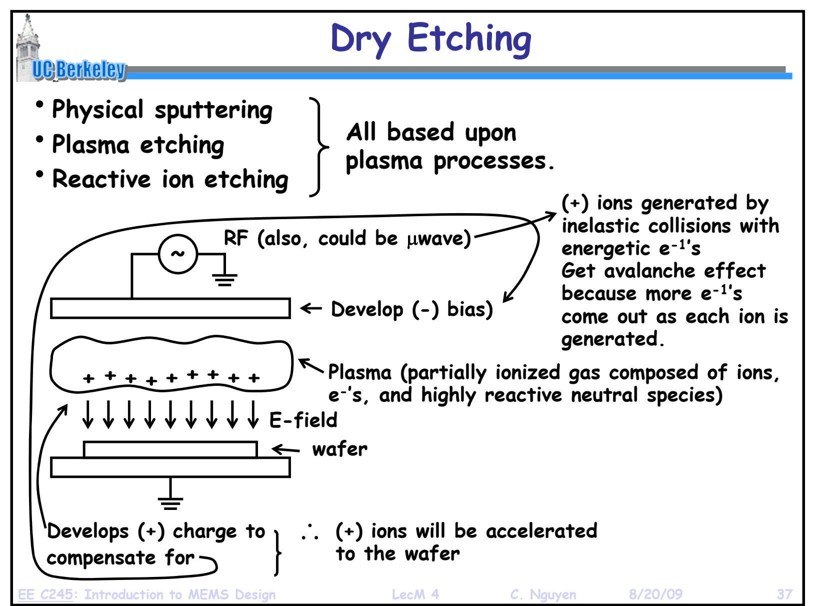
UC Berkeley

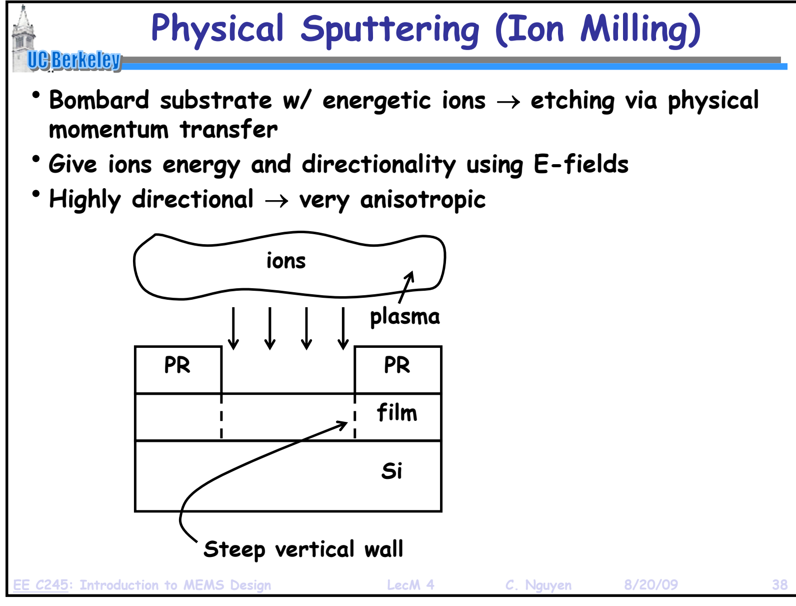
• For some popular films:

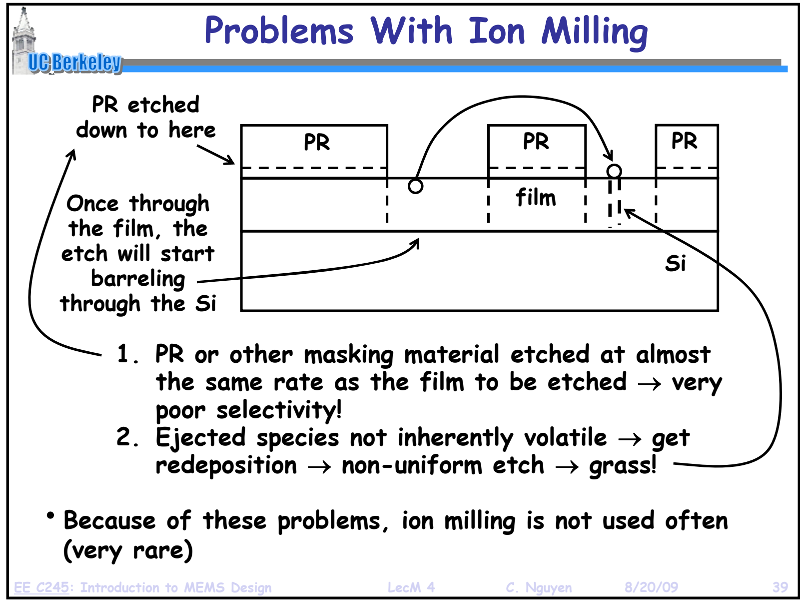
Material	Wet etchant	Etch rate [nm/min]	Dry etchant	Etch rate [nm/min]
Polysilicon	HNO_3:H_2O: NH_4F	120-600	SF_6 + He	170-920
Silicon nitride	H_3PO_4	5	SF_6	150-250
Silicon dioxide	HF	20-2000	CHF_3 + O_2	50-150
Aluminum	H_3PO_4:HNO_3: CH_3COOH	660	Cl_2 + $SiCl_4$	100-150
Photoresist	Acetone	>4000	O_2	35-3500
Gold	KI	40	n/a	n/a

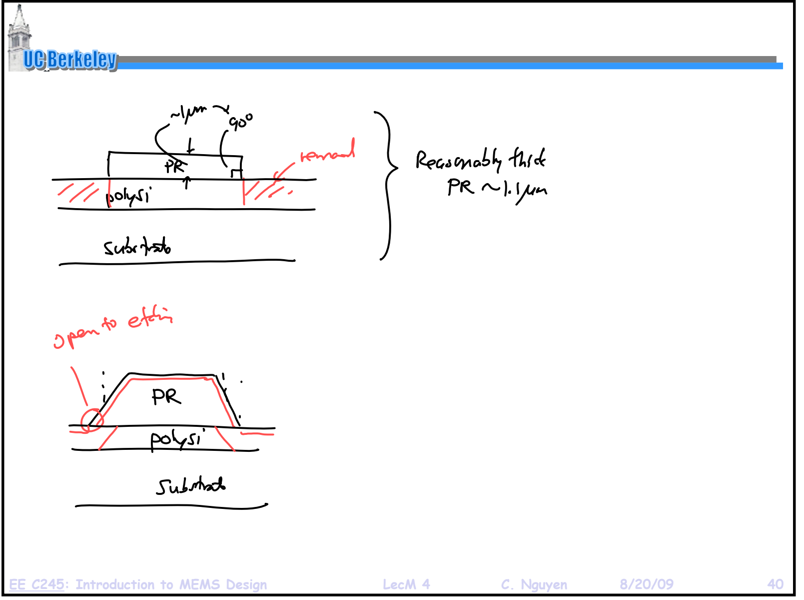
EE C245: Introduction to MEMS Design LecM 4 C. Nguyen 8/20/09 35

Copyright @ 2010 Regents of the University of California

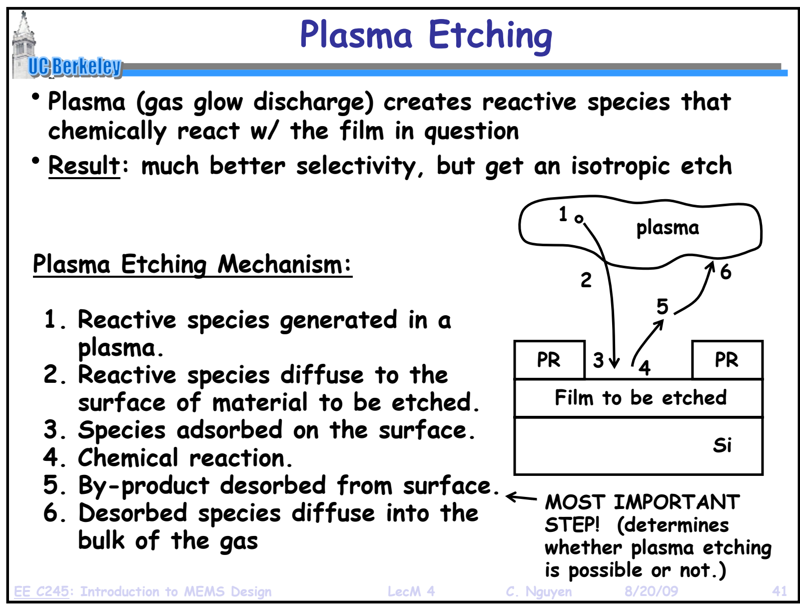


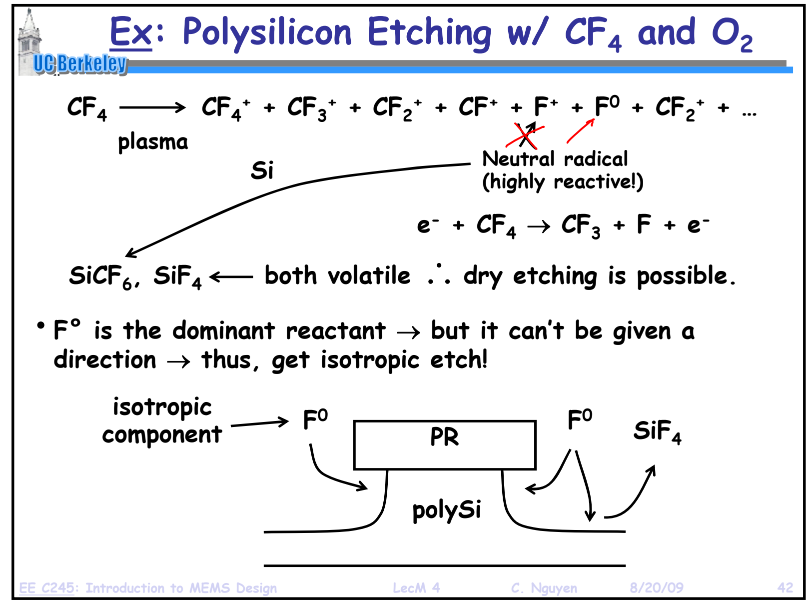


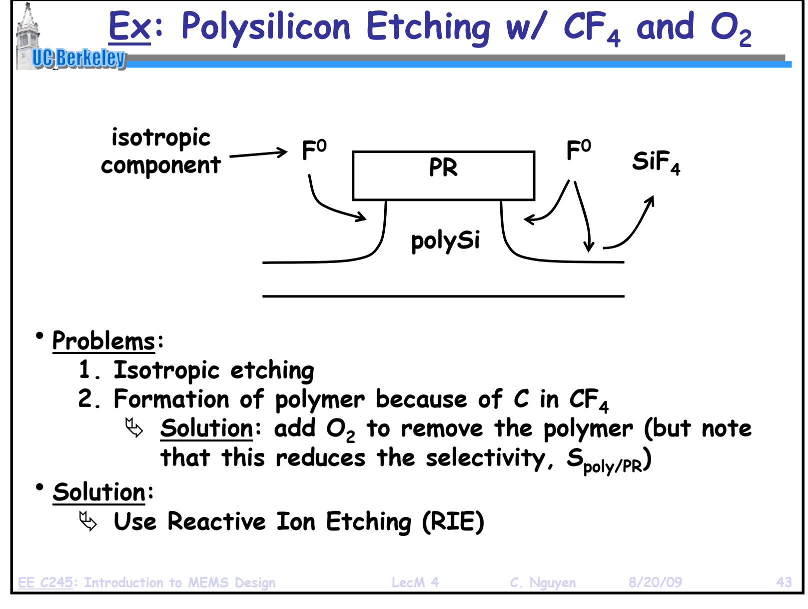


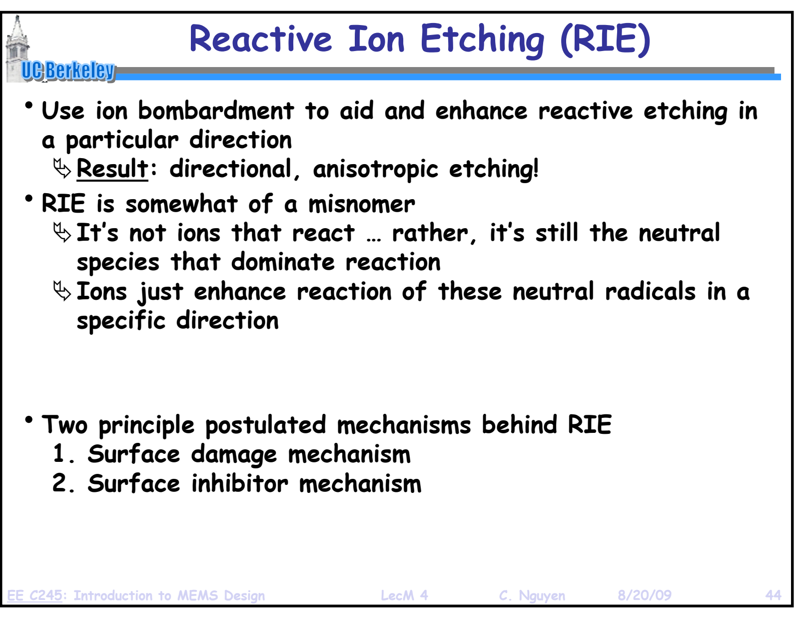


Copyright @ 2010 Regents of the University of California

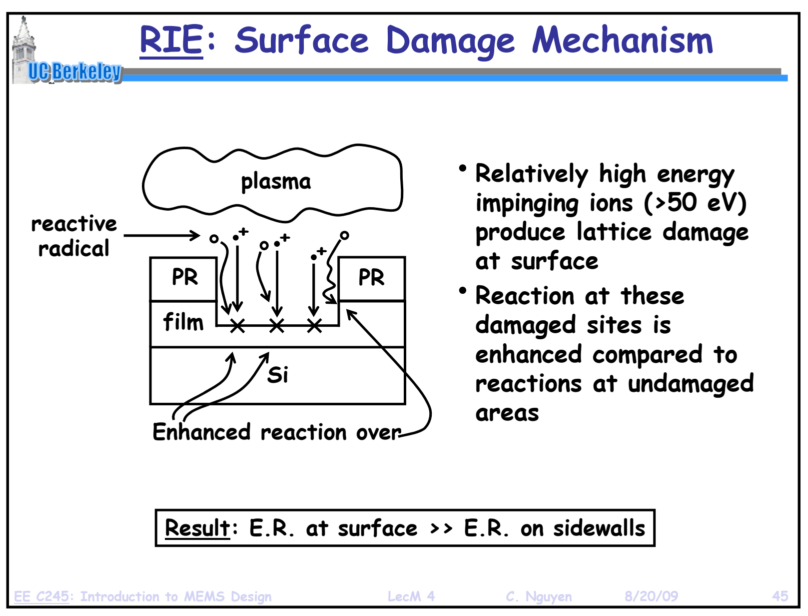


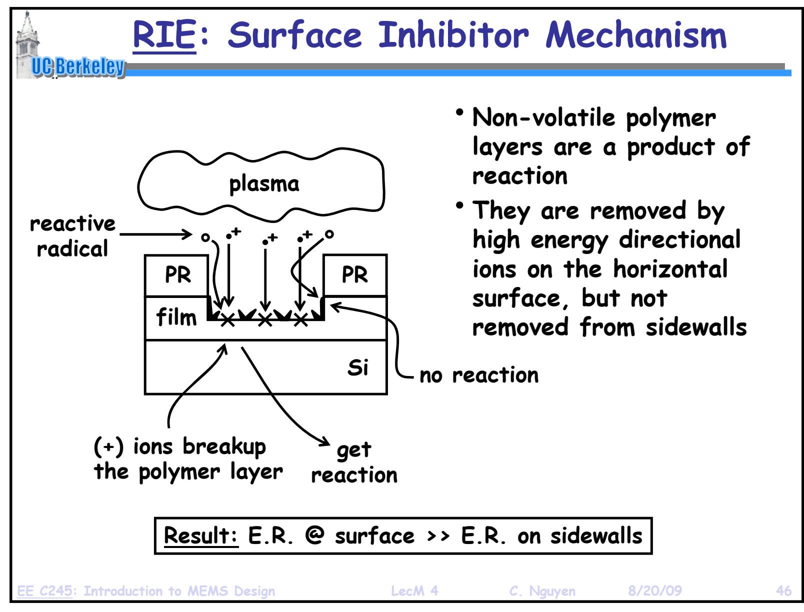


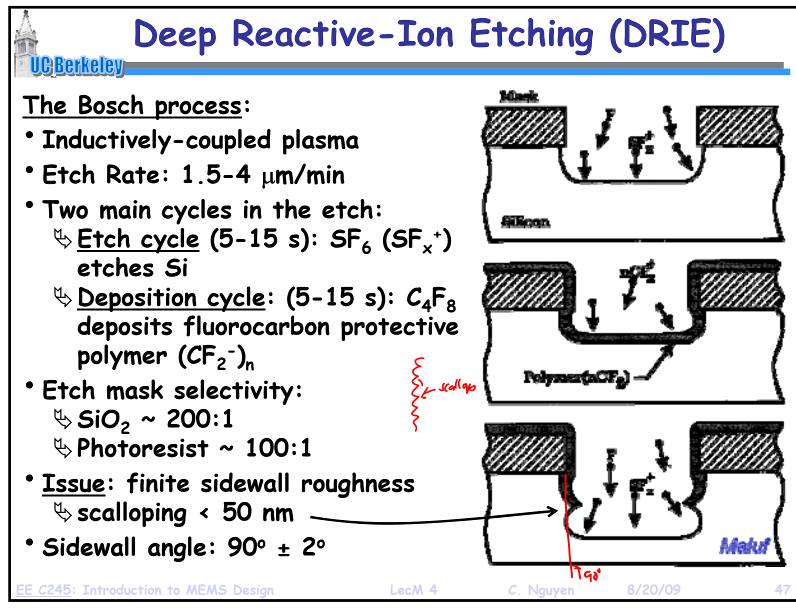


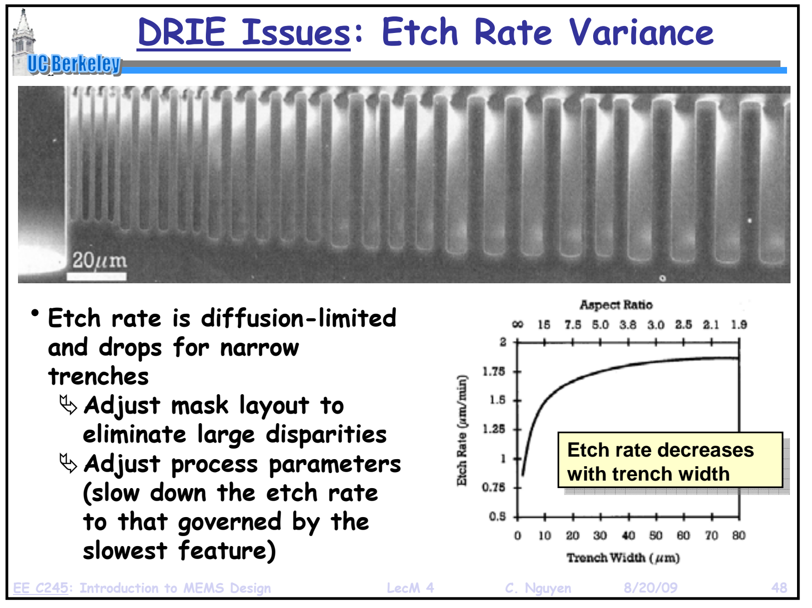


Copyright @ 2010 Regents of the University of California









Copyright @ 2010 Regents of the University of California