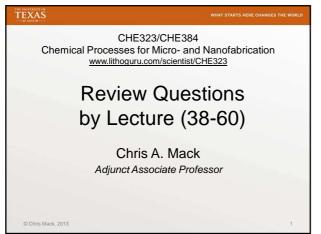
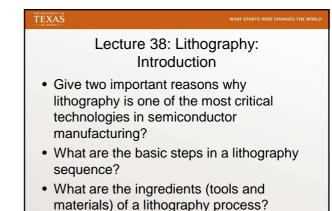
CHE 323, Chemical Processes for Micro- and Nanofabrication





INVERTING EXAS -AT AUSTIN	WHAT STARTS HERE CHANGES THE WORLD	TEXAS	WHAT STARTS HERE CHANGES THE WORLD
Lecture 39: Lith Process Ove	• • •	L	Lecture 40: Lithography: Imaging Tools
 How many requirements for name? What are the two main tasks How does an adhesion pror What is the relationship betwand spin speed? What is an edge bead, why what do we do about it? What is the purpose of a po Explain the two tones of pho 	s of a photoresist? noter work? ween resist thickness does it occur, and st-apply bake?	 contact prin What are the proximity p What are the exposed check What are the wavelength 	he advantages and disadvantages of rinting? hree ways of filling a wafer with hip patterns during projection printing? he two most common mercury arc lamp hs? he two common excimer laser types
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TEXAS

Lecture 41: Lithography: Diffraction, part 1

- Define "diffraction-limited imaging"
- What is a "spatial frequency"?
- Explain Huygens' Principle
- How does one calculate the Fraunhofer diffraction pattern from a mask?

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Lecture 42: Lithography: Diffraction, part 2

- Define constructive and destructive interference
- What is Bragg's Condition?
- What is a delta function, and what does it represent physically?
- What is a diffraction order and when do they show up in diffraction patterns?
- How does the size of a mask pattern affect its diffraction pattern?

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Lecture 43: Lithography: Projection Imaging, part 1 • Define "numerical aperture" • What are the entrance and exit pupils of an imaging lens?

- How can one determine which diffraction orders pass through an imaging lens?
- What is the pupil function of a lens?
- Explain the concept of Fourier Optics

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Lecture 44: Lithography: Projection Imaging, part 2 How can you determine which diffraction orders make it through the lens? Can you take the inverse Fourier transform of a sum of delta functions (diffraction orders)? A point of light (diffraction order) at the lens produces what type of wave at the wafer? What happens to the image if the lens captures more diffraction orders?

Lecture 45: Lithography: Lecture 46: Lithography: Illuminating the Mask Defocus and DOF · How does defocus affect the optical path · How does oblique illumination affect the difference (OPD) of light exiting the imaging diffraction pattern? lens? What is the Rayleigh resolution criterion? What is the "paraxial approximation"? What are the minimum values of k1 for 2-· Name three things that happen to an image beam and 3-beam imaging? as it goes out of focus What is the Rayleigh depth of focus · Define coherent, incoherent, and partially equation? coherent illumination What assumptions used in the Rayleigh DOF What is off-axis illumination? don't often apply to lithography today? © Chris Mack, 2013 © Chris Mack, 2013

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Lecture 47: Lithography: Standing Waves and Swing Curves

- · What causes a standing wave?
- Why are photoresist standing waves bad?
- Name four ways to reduce standing waves in resist. Which way is most commonly used?
- What is a swing curve?
- What is reflective notching?

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Lecture 48: Lithography: Resolution and Immersion

- What are the three ways to improve resolution in optical lithography
- Which of those three ways has had the biggest impact on resolution over the years?
- What currently limits our ability to improve each of these three factors?
- What is the current resolution limit for single patterning?

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	: Lithography: hotoresists		re 50: Lithography: otoresist ABCs
	najor components of a f photoresists that have onductor manufacturing osure affect resist	 How can one i How are the A measured? 	ABC parameters? ncrease the value of B? BC parameters typically al values of A for 248-nm esists?
What is reciprocity? Othris Mack, 2013	13	© Chris Mack, 2013	

TELENOISEUTO OF TEXASS	WHAT STARTS HERE CHANGES THE WORLD		WHAT STARTS HERE CHANGES THE WORLD
	1: Lithography: blified Resists, part 1	Che	Lecture 52: Lithography: mically Amplified Resists, part 2
 How are chemical different from conv line) resists? 	ly amplified resists rentional (g-line and i-		n the concept of reaction-diffusion s the diffusion point spread function)?
 What acts as the c amplification react 			s the reaction-diffusion point spread n (RDPSF)?
 Why are these res "chemically amplif 		amplifi	causes T-topping in chemically ed resists?
What are the two t affect change in a	ypes of "dose" used to CAR?		re base quenchers used in chemically ed resists?
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Lecture 53: Lithography: Resist Development

- What are the three steps in the Mack kinetic development model used here?
- What development parameter controls the performance of the resist?
- What is the physical meaning of the dissolution selectivity parameter, n?
- What is the development knee and why is it important?

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Lecture 54: Lithography: Resist Contrast

- How is the conventionally measured contrast defined?
- How is the theoretical contrast defined?
- When do the conventionally measured and theoretical contrasts give the same result?
- How is contrast related to the dissolution selectivity parameter n?

THE CONVERSION OF	WHAT STARTS HERE CHANGES THE WORLD	TEXAS	WHAT STARTS HERE CHANGES THE WORLD
	e 55: Lithography: ewidth Control		ture 56: Lithography: thographic Quality
 How does trans affect the device 	sistor gate CD variation	What are the lithographic	e four categories of quality?
 What two gene resulting variati 	ric factors determine the		idth versus dose often d on a log-log scale?
Name two proc	ess variables that result in	What metric of an aerial i	best characterizes the quality mage?
	r than linear CD response erence between bottom-up		e contrast (threshold) resist, ensitivity to dose related to

NILS?

Lecture 57: Lithography: Lecture 58: Lithography: Resolution Enhancement Technologies, part 1 Resolution Enhancement Technologies, part 2 What are the three main RET approaches? What are the two types of resolution? How does OAI improve resolution? What are the three main RET How does OAI improve depth of focus? approaches? What phase-shift do we want in a mask to Why is OPC needed in optical produce destructive interference? lithography? Which PSM approach is most common in What are the two main types of OPC, and manufacturing today? what are their advantages and • Explain the phase conflict problem for alternating PSM disadvantages? © Chris Mack, 2013 © Chris Mack, 2013

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Lecture 59: Lithography: Double Patterning

 What is the current resolution limit of single patterning?

and top-down CD error analysis

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- Name three double-patterning approaches
- What are the main advantages and disadvantages of each double patterning approach?
- Essay question: do you think there is a future for quadruple patterning? Why or why not?

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Lecture 60: Lithography: Extreme Ultraviolet

- What is the current resolution limit of single patterning?
- Why does EUV imaging use only mirrors in the projection system?
- What are the main challenges in EUV masks?
- What are the main challenges in EUV sources?
- What are the main challenges in EUV resists?

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