NSF/SRC CEBSM
Teleconference
February 24, 2000

Distance Course Delivery and Student-Instructor Interaction

Greg Raupp
Arizona State University
CHE 458/598
Semiconductor
Materials Processing

- Senior / grad technical elective
- Unit processes of semiconductor manufacturing
- Emphasis on understanding through 1st Principles modeling
Delivery Modes

- Live in ASU studio
- Television
  - ITFS remote site network
  - NTU
- Live WebCast
Student Diversity

- Undergraduate
- Graduate: Ph.D., M.S., non-thesis Masters (SPM Program)
- Full-time students, part-time students, full-time professionals
- Disciplines: CHE, MSE, EE, IE, CHM, PHYS
Course Web Site

- **All students** access the site for announcements, course materials incl. lecture slides, assignments, communication

- **Two-step initial access process:**
  - navigate to [http://asuonline.asu.edu](http://asuonline.asu.edu), select CHE 598 and **Register**
  - Once at course site, click **Enroll**
Blackboard CourseInfo 4.0

- ASU site license through DLT
- provides uniform look, features, structure
- data-based structure -- no need for HTML expertise
- http://www.blackboard.net
You are welcome to visit the site! Two guest accounts are available --

Username: **CEBSMGuest1** and **CEBSMGuest2**
Password: **green**
Subject: Announcement

Welcome to the CHE 458/598 Semiconductor Materials Processing Courseinfo Web Site. The live WebCasts can be accessed through Course Documents. Please take a few moments to browse through the rest of the site so that you are able to access the learning and communications resources you need.

I look forward to working with you this semester.

- Greg Raupp

Subject: Announcement

If you have questions with the content of the course during a live class session, or if you are experiencing technical difficulties with signal transmission/receipt at your remote site, you may phone in to the studio at (480) 965-4437. Your call will first be screened by our studio technician. If you have a question for me, you will be patched forward to the lecture desk. At that time I will answer the phone, and all students will be able to hear your question.

- Greg Raupp

Subject: Announcement

In addition to the Web-cast archive, ITFS broadcast-quality archived videos of the class are maintained by the Library on VHS tapes, and can be viewed by contacting University Libraries Video Resources at (430) 965-5046. Videotaped class sessions are available for the entire semester.

- Greg Raupp
Course Information

Current Location: Course Information

- Syllabus
- Your Instructor
- System Requirements for Online Video
  Link to File

Student Tools

- Student Drop Box
- Change Your Information
- Check Your Grade
- Edit Your Homepage
- Student Calendar
- Student Pages
- Student Manual
Current Location: Course Documents

Live WebCast

CHE 598 is WebCast live Monday and Wednesday from 6:40-7:55pm MST.

The archived version of the class video will be available within 24 hours of the original class time.

Consult “System Requirements for Online Video” in Course Information for more information.

WebCast Archive
Powerpoint Files
Supplementary Learning Modules

16 fps low resolution
This course includes video material that can be accessed online using the free RealPlayer from RealNetworks. If you do not already have the RealPlayer installed on your computer, you can download RealPlayer 7 or G2 using the links below. *(Note: You do not need to purchase the RealPlayer Plus).*

### System Requirements for Online Video

<table>
<thead>
<tr>
<th>PC</th>
<th>MACINTOSH</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Windows 95, Windows 98, or Windows NT 4.0 with Service Pack 3</td>
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<tr>
<td>- 120 MHz or faster Intel Pentium processor (or equivalent)</td>
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<tr>
<td>- 32MB of RAM or more</td>
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<tr>
<td>- 28.8 Kbps modem or faster (56.6 Kbps modem or faster connection recommended)</td>
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<tr>
<td>- 16-bit sound card and speakers</td>
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<tr>
<td>- 65,000-color or better video display card</td>
<td></td>
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<tr>
<td>- Internet connection and web browser</td>
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<tr>
<td>- 30 MB free space on your hard disk</td>
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</tbody>
</table>

- Mac OS 8.1 or later
- PowerPC G3 or G4 processor (233 MHz or faster)
- 64 MB RAM and 65 MB virtual memory
- 28.8 Kbps modem or faster (56.6 Kbps modem or faster connection recommended)
- Speakers
- Internet connection and 4.0 web browser
- 25 MB free space on your hard disk

**Free RealPlayer**

**Substantial performance enhancement at higher speeds**
Powerpoint Slides

- Large simple font
- Clear visuals
- Simple graphics
- Outlines
- Limited information
- Equation editor
• Describe and model effects of substrate orientation and dopant concentration in Si thermal oxidation

• Describe and model production of $\text{Cl}_2$ in halogenic thermal oxidation of Si through conventional and point-of-use methods
Molecular processes in D-G model

1. oxidant adsorption & absorption
2. oxidant diffusion through film
3. reaction at interface
Model - Experiment comparison: wet ox

Model prediction

data

good match at short and long times

oxide thickness

10 hr

time
Thermal oxidation in the presence of halogens

- Motivation
- Chemical equilibrium based model for Cl₂ concentration in furnace tube
- Manufacturing and Environment, Safety and Health (ESH) issues and solutions
Motivation for halogen use

- enhances dielectric strength: hydroxyl (OH) conversion
- neutralizes impurities
Halogenic Thermal Oxidation

$O_2$  $HCl$

$C (\text{mol/cm}^3)$

$HCl$  $Cl_2$
Chemical equilibrium constraint: extent expression simplified

\[ K_p(T) = P^{-1} \cdot \frac{(2\xi)^4 \cdot (20-\xi)}{(1-4\xi)^4 \cdot (19-\xi)} \]

For given \( T, P \)

single equation in single unknown: solve iteratively for \( \xi \)
Concerns with HCI

- ES&H: Environment, Safety & Health issue: worker exposure (S&H)
- Manufacturing issue: corrosive to equipment and supply lines (maintenance and reliability)
- Solution: convert process to “point-of-use” operation
Point-of-use halogenic thermal oxidation with TCA

\[ O_2 + 1,1,1-TCA \rightarrow Cl_3C-CH_3 + 2O_2 \rightarrow 3HCl + 2CO_2 \]

fast, irreversible reaction
ES&H concern with 1,1,1-TCA

- **Environmental issue:** TCA extremely stable in atmosphere
- **GWG** - global warming gas
- **Solution:** convert process to “point-of-use” operation with dichloroethylene (*trans*-LC™)
Remote Student - Instructor Interaction

• Live instructor call-in
  – phone number given on Web page
  – audio through the TV or PC, not the phone

• Threaded Discussion Board

• On-line Office Hours (Chat Room)

• E-mail
### Discussion Board

**Forum:** Technical Forum

**View Unread Messages**

<table>
<thead>
<tr>
<th>Title</th>
<th>Author</th>
<th>Date</th>
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<tbody>
<tr>
<td>assignment 2a - radial boundary condition</td>
<td>Martin, Edward L</td>
<td>30-Jan-2000</td>
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<tr>
<td>Re: assignment 2a - radial boundary</td>
<td>Raupp, Gregory</td>
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<td>Raupp, Gregory</td>
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<td>assignment 3b</td>
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<td>Re: assignment 3b</td>
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<td>Assignment #9</td>
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[Click Here for Archives]

**Sort By:** Default

**Back to Forum View**
Whiteboard to facilitate ...

- Participant info
- Slide navigation
- Access control

Questions & Answers
use the box on the right to submit questions to the instructor.
Assignment Submission

- hard copy (couriers)
- fax copy
- soft copy: Web-site dropbox
  - Office 97 (Word, Powerpoint, Excel)
  - Mathcad 6.0 Plus
  - Matlab 5.0
  - scanned image files
Key concern: Student-Instructor Connection

- Show your human side
- Use ice-breakers
- Try limited interactive exercises
- Be responsive -- especially early in the course
- Student pages
# Overall Performance S99

<table>
<thead>
<tr>
<th>Grade</th>
<th>Studio</th>
<th>TV</th>
<th>Web</th>
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</thead>
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<td>W</td>
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</table>
Feedback from Students I

- Chat room beneficial
- Instructor response time good
- Discussion board beneficial
- Sufficient opportunity to interact with other students

Options:
- Strongly disagree
- Disagree
- Neutral
- Agree
- Strongly agree
Feedback from Students II

• Most positive aspect: availability of archived lectures
• Most common complaint: low quality of Webcast, net congestion, unstable connections
• Course content and difficulty, workload level met expectations