

MMAT 4241- Nanomaterials

(Characterization, Application)

Basic Details

- Instructor: Prof. Bryan D. Huey
- Lecture Location: Bronwell 124
- Lecture day/time: Every Tuesday, Thursday; 9:30-10:45 pm
- Office Hours: 11:30-12:30 Wednesdays
- Office Location: IMS Plaza Room 158 (Gant Bldg.)
 - Phone: 486 3284
 - Email: bhuey@ims.uconn.edu
- Textbook: Introduction to Nanoscale Science and Technology by M. Di Ventra, S. Evoy, J. Heflin, Springer (2004)
- Additional Readings: Modern research papers will also be assigned regularly for in-class discussions.
- Some material will be uploaded to the course web site, reached from: <http://www.ims.uconn.edu/~bhuey>



Course Goals

- Materials Science is frequently the limiting factor in realizing the benefits of nanoscale science and technology.
- This course will introduce students to nanoscale materials and device fabrication, assembly, characterization, and operation, with an **emphasis on materials science principles which allow these achievements**.
- Along with textbook readings and assignments, we will also **read and discuss recent publications** in this rapidly expanding area of research, development, and applications.
- Students will have an opportunity to gain the following specific skills and abilities through lectures, class participation, and assignments:
 - a. an ability to apply knowledge of mathematics, science, and engineering
 - g. an ability to communicate effectively
 - h. the broad education necessary to understand the impact of engineering solutions in a global and societal context
 - i. a recognition of the need for, and ability to engage in, life-long learning
 - j. a knowledge of contemporary issues



Grades

Homework (5*10%)	50%
Quizzes (3*5%)	15%
Research Paper Summaries (4*3%)	12%
Lead of Research Paper Discussion (1*5%)	5%
Class Participation (6%)	6%
Oral Term Presentation	12%
<i>Extra Credit (up to 1*5%)</i>	+5%

Graduate Students: Expectations are proportionately higher.

term score	term grade	term score	term grade
>92	A	>72	C
>90	A-	>70	C-
>88	B+	>68	D+
>82	B	>62	D
>80	B-	>60	D-
>78	C+	<	F



Class Participation

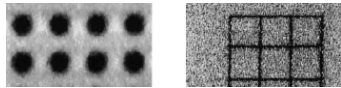
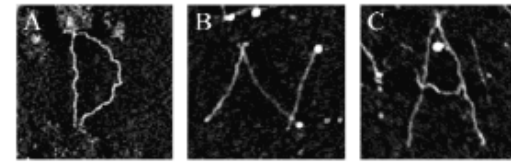
- In addition to textbook reading and light assignments, we will often discuss papers on nanomaterials from modern research that you will have read.
- Expectations
 - 1) Have a prepared written summary of the key points in the paper (sometimes due for points), which includes:
 - The main idea
 - Something you learned
 - Something you didn't like about the paper
 - Suggestions for what you or the authors could/should do next based on what you read
 - No more than ½ page
 - Collected at the end of some discussions
 - 2) Be prepared to discuss the paper based on these, and other, observations / insights.

NOTE: *Just because these are published papers does not mean you cannot disagree with what the authors say/do. It is expected that each person will have a different perspective—there is no right vs. wrong answer, just thoughtful vs. unprepared.*

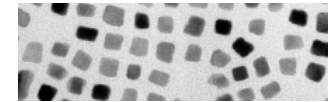




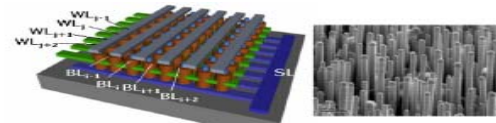
1. none
2. Nanobots to the attack
3. DNA patterns by AFM manipulation
4. nano-welding of Cu filled nanotubes
5. Lithographically patterned nanowire deposition



6. **Dip pen nanolithography**
7. Self assembly of FePt nanocubes



8. Self assembly review
9. none



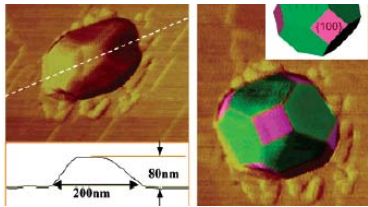
10. Grain rotation of nacre upon mechanical compression



11. Wires, belts, and tubes



12. **submarine nanocoatings**



13. Nanopyramids

14. **Self assembled molecular switches**



15. none

16. none

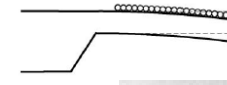
17. Molecular rack and pinion



18. **Alphabet soup**

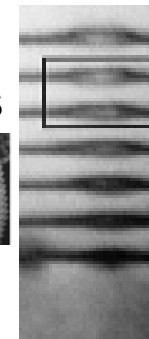


19. **Cantilever array sensors for mass, temp,**

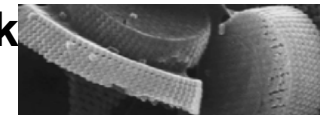


20. Milk, beer, and juice detectors

21. Vertically stacked, self assembled, quantum dots

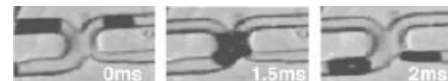


22. **Photonic crystal algae sunblock**



23. **Diode motorboats**

24. Microfluidic bubble logic



Final Presentation

- **Each student will give an oral presentation about a nanomaterial**
 - based on articles in several journals I will bring to class
- Topic assigned before Spring break
- The presentation should discuss:
 - fabrication;
 - characterization;
 - application;
 - and benefits over non-nano variations.
- Expectations
 - 12 minute presentation, 3 minutes questions
 - Based on supplied article, plus at least 3 extra papers/textbooks beyond class materials.
 - Include figures/graphs/animations.
 - Must be properly referenced (figures, ideas, and text must be footnoted).
- given on last 3 days of class (Apr. 23, 28, 30)
 - Day/order determined by lottery



Final Presentation Topics

- Essentially on modern nanomaterials beyond what we've done in class:
 - Phosphors (plasma screens)
 - Catalysts (Catalytic Converters)
 - Nacre (natural nanostructuring)
 - Anti-stain coatings (clothing)
 - TiO₂ ZnO, ZrO₂ powders (sunscreens, paints)
 - Thin films (Polarizing coatings for glasses)
 - Molecular dyes (bio-imaging)
 - Gore-Tex (waterproofing)
 - Silver Halide nanocrystals (cloud seeding=making rain)
 - Teflon (cookware coatings)
 - Data storage media (hard drive bits)
 - IC's



Extra Credit Opportunity

- Find reference to nanomaterials, nanoscience, or nanotechnology in popular culture.

- Songs
- TV shows
- Commercials
- Movies
- Games
- Books
- Print Advertising
- Products



- Up to 5 submissions per student allowed (+1% on your grade for each acceptable submission).
- No duplicates, so this will get harder as the semester goes by...
- I will accept:
 - Scans of web-versions of print media (newspaper/magazine clippings)
 - emailed/thumb-driven figures/lyrics/animations/video



Syllabus I

Date	Lecture	Topic	Reading	Remarks
1/20	1	Introduction	None	
1/22	2	Electron Microscopy	Ch 3	paper summary due
1/27	3	AFM and Nanoindentation	Ch 3	paper discussion
1/29	4	SPM and Nanolithography	Ch 3	Quiz 1
2/3	5	Optical lithography	Ch 1	HW 1 due
2/5	6	Advanced Lithography	Ch 1	paper discussion
2/10	7	Modern Transistors	Ch 9,10,11,12	paper discussion
2/12	8	Next Generation Transistors	Ch 9,10,11,12	paper summary due
2/17	9	Review-Particle in a Box / electronic and optical properties	Any intro quantum text (pchem or physics)	HW 2 due
2/19	10	Single Electron Transistors	Ch 9,10,11,12	paper discussion
2/24	11	Self Assembly I	Ch 2	paper discussion
2/26	12	Self Assembly II	Ch 2	Quiz 2
3/3	13	MEMS/NEMS I	Ch 15,16,17	HW 3 due
3/5	14	MEMS/NEMS II	Ch 9,10,11,12	paper discussion
3/10		No Class: Spring Break		
3/12		No Class: Spring Break		
3/17		No Class		
3/19		No Class		



Syllabus II

Date	Lecture	Topic	Reading	Remarks
3/10		No Class: Spring Break		
3/12		No Class: Spring Break		
3/17		No Class		
3/19		No Class		
3/24	15	Quantum Dots	Ch 19,20	paper summary due
3/26	16	Magnetic Storage Devices	Ch 13,14	paper discussion
3/28		Emergency Snow Day		
3/31	17	Next generation data storage		Quiz 3
4/2	18	Nano and Energy	???	paper discussion
4/7	19	Nano and Carbon and other	Ch 4,5,6	HW 4 due
4/9	20	Nano-demos	???	paper discussion
4/14	21	Nano-bio-mimetics	Ch 21,22,23	Paper summary due
4/16	22	Nano and cells / creatures		paper discussion
4/21	23	Nano-bio-fluidics / drug delivery	Ch 21,22,23	HW 5 due
4/23		Presentations		
4/28		Presentations		
4/30		Presentations		
5/4		Presentations, 8-10am		



Policies and Procedures-Homework

- **All homeworks are due by the start of class (9:30 am) on the stated deadline.**
- **Late Policy:**
 - If you submit the assignment later on the due date instead (by 4:30 pm), you will lose 10%
 - if you submit the assignment 1 day late, you will lose 25%
 - if your assignment is even later *but* submitted before everyone else's is returned, you will lose 50%;
 - beyond that time you will earn no credit.
 - Late assignments go to my office or under my door
- **If you wish, you may work together on homework assignments.**
 - Do not directly quote/copy other work (other books, web pages, etc).
 - Copied work is cheating—it is not permitted.
 - Those who rely on their peers for homework tend to suffer on quizzes/final projects.

