

**THE OHIO STATE UNIVERSITY
DEPARTMENT OF MECHANICAL ENGINEERING**

**ME 837 NANOTRIBOLOGY, NANOMECHANICS, AND NANOMATERIALS
CHARACTERIZATION FOR NANOTECHNOLOGY**

Spring 2006

- Lecturer:** Professor Bharat Bhushan
(Suite 605, 650 Ackerman Road, ext. 2-0651)
- Text:** B. Bhushan, *Nanotribology and Nanomechanics - An Introduction*, Springer-Verlag, Heidelberg, Germany, 2005.
- Reference Books:** B. Bhushan, *Introduction to Tribology*, Wiley, N.Y., 2002 (recommended).
- B. Bhushan, *Springer Nanotechnology Handbook*, Springer-Verlag, Heidelberg, First ed., 2004; second ed., 2006 (recommended).
- B. Bhushan, *Principles and Applications of Tribology*, Wiley, N.Y., 1999.
- B. Bhushan, *Handbook of Micro/Nanotribology*, Second edition, CRC Press, Boca Raton, Florida, 1999.
- B. Bhushan and B.K. Gupta, *Handbook of Tribology: Materials, Coatings and Surface Treatments*, McGraw Hill, N.Y., 1991.
- Lecture Room/
Time:** Central Classroom (CC) 340,
9:00 – 10:12 AM
Monday and Wednesday
- Exams:** Exam No. 1 – April 26, 2006
Exam No. 2 – May 24, 2006
- Project:** A take home project will be assigned.
(Written report due – May 24, 2006)
- Office Hours:** Monday and Wednesday
10:30 to 11:30 a.m.
- Grading:** 2 Midterm Exams 70%
Project 30%

Spring Qtr. 2006 2-1½ hr. Class Prerequisite: None
 Instructor: Prof. Bharat Bhushan, Suite 605, 650 Ackerman Road; Telephone: 292-0651
 Course Evaluation: 2 Midterm exams and a project

Nanotechnology literally means any technology done on a nanoscale that has applications in the real world. Nanotechnology encompasses production and application of physical, chemical, and biological systems at scales, ranging from individual atoms or molecules to submicron dimensions, as well as the integration of the resulting nanostructures into larger systems. Science and technology research in nanotechnology promises breakthroughs in areas such as materials and manufacturing, nanoelectronics, medicine and healthcare, energy, biotechnology, information technology and national security. There is an increasing need for a multidisciplinary, system-oriented approach to design and manufacturing of micro/nanodevices which function reliably. This can only be achieved through the cross-fertilization of ideas from different disciplines and the systematic flow of information and people among research groups. Reliability is a critical technology for many micro- and nanosystems and nanostructured materials.

The objective of this interdisciplinary course will be to study the principles of nanotribology and nanomechanics, nanomechanical characterization techniques and applications to micro/nanotechnology.

COURSE OUTLINE

1. Introduction to Micro/Nanotechnology
 Definition, Examples, Importance of Nanotribology and Nanomechanics
2. Micro/Nanofabrication and Examples (D. Hansford)
 Top down – Photolithography, Soft lithography; Bottom up – Self Assembly
 Examples BioMEMS/BioNEMS/Polymer MEMS
3. Introduction to Tribology I
 Surface Characterization, Adhesion, Friction, Interface Temperatures
4. Introduction to Tribology II
 Wear and Lubrication
5. Nanocharacterization Techniques – SFA, STM, AFM and Nanoindenter
 Introduction and Examples of Data
6. Introduction to Nanotribology I
 Surface Imaging, Adhesion, Friction, Interface Temperatures
7. Introduction to Nanotribology II
 Scratching, Wear, Indentation, Nanofabrication
8. Nanotribology of MEMS/NEMS
 Tribological Studies of Si and Related Materials
 Device Level Studies
9. Nanomechanics of Nanostructures
10. Self-Assembled Monolayers (SAMs) (J. Coe)
 Introduction, Examples, Deposition Techniques, and Characterization
11. Nanotribology of SAMs and Perfluoropolyethers (PFPEs)
12. Nanotribology and Nanomechanics of Hard Coatings – DLC
13. Morphology, Adhesion, Friction, and Wear of Biomolecules for BioMEMS/NEMS
14. Superhydrophobicity (Lotus Effect) and Gecko Feet
 Surface Characterization, Adhesion and Friction of Leaf Surfaces and Nanopatterned Polymers
 Modeling of Nanopatterned Structures for Smart Adhesion
15. Nanotribology and Nanomechanics of Human Hair and Hair Conditioner