

NANOPROBE LABORATORY FOR BIO- & NANOTECHNOLOGY AND BIOMIMETICS (NLBB)

201 W. 19th Avenue, W374A-E, W376, W380, W381, W390, W392 Scott Laboratory
The Ohio State University,
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Introduction

A major nanoprobe laboratory with a focus on bio/nanotechnology and biomimetics was organized in July 1991 with the initial financial support from the state of Ohio and The Ohio State University. More than 5700 square feet of laboratory space was made available for this purpose. The laboratory is populated with the modern scientific equipment needed to conduct state-of-the-art research.

Goals and Scope

NLBB's main goals are to carry out fundamental studies in the interdisciplinary areas of bio/nanotribology, bio/nanomechanics and bio/nanomaterials characterization and applications to bio/nanotechnology. The scope of the research includes the development of theoretical models, development of sophisticated instrumentation and techniques, fabrication of nanostructures, and the acquisition of research data for fundamental understanding. Measurement of mechanical and electrical properties of nanostructures is carried out. Self-assembled monolayers and perfluoropolyether lubricant and ionic liquid films are developed for

micro/nanostructures. Biomolecular films are studied for biomedical applications. In particular, bioadhesion, friction and wear issues are addressed. Another main goal is to develop bio-inspired nanostructured surfaces. There is a large activity on superhydrophobic and self-cleaning surfaces with low drag (Lotus effect) and interfaces with smart adhesion (Gecko feet). There are also research activities in nanoprobe based data recording technology and beauty care products (hair, hair conditioner, and skin cream). Instrumentation used in the lab includes atomic force microscopy/scanning tunneling microscopy (AFM/STM), microtriboapparatus, nanoindenter, and industrial simulators.

The research activity is truly interdisciplinary, embodying materials science, physics, physical chemistry, biomedical engineering, biotribology, lubricant rheology, mechanics, applied mathematics, and bio/nanomaterials characterization and applications to bio/nanotechnology and biomimetics.

Laboratory Director

Dr. Bharat Bhushan

Ohio Eminent Scholar and The Howard D. Winbigler Professor and Director, NLBB

- Fundamental studies with a focus on scanning probe techniques in the interdisciplinary areas of bio/nanotribology, bio/nanomechanics and bio/nanomaterials characterization in bio/nanotechnology and biomimetics.

Facilities and Equipment

The Nanoprobe Laboratory is housed in Scott Laboratory. The laboratory occupies more than 5700 square feet of space. Office space includes offices for the two faculty members, a secretary, six visiting scientists/industrial fellows, and 16

graduate students. Part of the laboratory is environmentally controlled and contamination controlled to a specification of Class 100. The air tables are used to provide vibration isolation.

The laboratory is equipped with many pieces of sophisticated research equipment including a scanning tunneling microscope, five atomic force microscopes, noncontact optical profiler, stylus profiler, nanoindenter, ultra-high vacuum tribotest apparatus, microtriboapparatus, and scanning ellipsometer, and contact angle measurement apparatus. The other pieces of equipment and facilities include vapor and liquid coating-deposition facilities, pin-on-disk continuous sliding test apparatus, reciprocating sliding test apparatus, microhardness tester, optical microscope, metallurgical sample preparation and polishing facility, particle counter, microbalance, and environmental chambers.

Central facilities for micro/nanofabrication of structures are used for bio/nanotechnology and biomimetics research. An easy access exists to various physical and chemical analysis facilities such as scanning electron microscope, scanning transmission electron microscope, EDS, scanning Auger spectrometry, X-ray photon spectroscopy, time-of-flight SIMS, DTA, DSC, TMA, TGA balances, porosimeter, NMR, FTIR, mass spectrometry, laser spectroscopy, and computer controlled mechanical test equipment.

The department has extensive computer facilities. In addition, the University maintains the Ohio Supercomputer Center. All of the campus computers are connected electronically.

Ongoing/Proposed Research Projects: Partial Listing

Nanotribology and Nanomechanics

- Normal and Lateral Force Calibration Techniques for AFM Cantilevers
- AFM-Based Nanotribological and Electrical Characterization of Ultrathin Wear-Resistant Ionic Liquid Films
- Nanotribological Properties of Novel Lubricants for Magnetic Tapes

Bio- & Nanotechnology

- Influence of Water on the Interaction Between Graphite and Carbon Nanotubes
- Boundary Slip and Nanobubble Study in Micro/Nanofluidics with Atomic Force Microscope
- Morphology and Mechanical Properties of Block Copolymer Films for Bone Regeneration Applications (with Prof. S. Schricker, College of Dentistry)
- Friction and Wear of New Dental Materials (with Prof. S. Schricker, College of Dentistry)

Biomimetics

- Lotus Effect: Roughness-Induced Superhydrophobic Surfaces
- Mechanically Durable Superhydrophobic, Self-Cleaning, and Low-Drag Surfaces with Hierarchical Structure
- Gecko-Inspired Hierarchical Structures for Reversible Adhesion

Beauty Care Products

- Adhesion, Friction, and Wear Characterization of Skin and Skin Cream Using Atomic Force Microscopy

Batteries Aging

- Aging Mechanisms in Lithium-ion Batteries (with Profs. S. Babu, G. Rizzoni, and Y. Guezennec, College of Eng.)

Additional projects can be initiated by industrial sponsors.

Industrial Membership Fees

There are four levels of membership: Member, Advisory Member, Senior Member, and Corporate Member. The annual membership fee is an unrestricted annual grant to NLBB at the levels of \$25,000 per year for the Member, \$50,000 for the Advisory Member, \$75,000 for the Senior Member, and \$100,000 for the Corporate Member. A company can become a member of NLBB on a trial basis with a first year fee of \$15,000. The membership can begin at any time. The funds will be used to fund faculty-directed research. NLBB also encourages industries to initiate contract research with the faculties associated with the NLBB. The costs usually run about \$60,000 to \$100,000 per year for a 12 month research program.

Sponsor Benefits

The Advisory Council will govern the NLBB. The Advisory Council will consist of both faculty and industry members, chaired by the Director of NLBB. The Advisory Council will determine the topics for faculty-directed research based on the recommendations made by the participating industry and faculty members. Member will have limited access to the lab facilities. Advisory, Senior and Corporate members will be allowed to initiate research projects. A trial member will not have any access to lab facilities. Industry/University Technical Exchange Meetings will be held at least once per year. Industry members will be encouraged to visit individually at their convenience throughout the year. The members of the NLBB will receive all written reports before they are submitted for external publication

or are available for general distribution. The member may send one representative to any of the short courses offered by the center. Each industry member may place a Visiting Industrial Fellow in residency for any period. A list of students for summer and full employment will be periodically provided to the participating members.

