

Nano-Tribology

Ph.D winter school January 19 to 30, 2009

**Technical University of Denmark, Mechanical Engineering Department
Building 427S, DK-2800 Lyngby**

Language:	English	Point (ECTS):	5
Form:	Lectures and invited speakers. Project work		
Examination:	Report and oral examination on Friday January 30, 2009.		
Aid:	Allowed.		
Evaluation:	Passed/Not Passed. External examiner		
Qualified			
prerequisites:	Basic skills in solid mechanics, fluid mechanics and Fortran or C programming.		
Participants			
restrictions:	Minimum 8, maximum 24.		

Tribology is the science and technology of surfaces in relative motion. This discipline which involves friction, lubrication and wear plays a crucial role in both research activities and practical applications. The interest in nanotribology has been increased during the last decade as the size of parts in micro/nano devices is continuously decreasing. In spite of this the fundamental mechanisms behind tribology are practically undiscovered except in the case of conventional hydrodynamic lubrication.

An intense research effort to reveal the tribological origins was initiated 15-20 years ago by several physical and chemical societies all over the world. The new research angles were the increasing possibilities to observe surfaces at the nano-scale and the rapidly increasing computer processing capacity for simulations.

The nanotribological research has not yet solved the tribological challenge but has and is still clarifying elements of the sliding friction puzzle: These are the topics of the present course.

List of lecture topics:

- Introduction to nanotribology with a state of the art overview of the stage of the research.
- Nanotribological contact mechanics.
- Nanotribological simulations and theories. Computer modelling.
- An example of nanotribological experimental method: The friction force microscope (FFM).
- A number of applications including:
 - Nanotribological investigations of the lubricity of Dimethyl Ether (DME) at DTU.
 - Theory of rubber friction at the nano-scale with applications to the tire and the medical industry.
 - Friction of polymers with application to the medical industry.
 - Micro/nano processing: A research area at DTU.

Invited guest lectures include:

B.O. Jacobson, Professor, University of Lund, Sweden.

U. Tartaglino, Dr., Pirelli Tires, Milan, Italy and Forschungszentrum Jülich, Germany.

B.N.J. Persson, Dr., Institut für Festkörperforschung Teori 1, Forschungszentrum Jülich, Germany.

E. Meyer, Professor, University of Basel, Switzerland.

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Fee: 300 € including course material and lunches.

Program:

Date	Day	Morning (9.00-12.30)		Afternoon (13.00-17.00)
01-19	Monday	Welcome	Introduction to Nanotribology (I.M. Sivebaek)	Visit to laboratories
01-20	Tuesday	Elastohydrodynamic lubrication (EHD) (B.O. Jacobson)		Project work
01-21	Wednesday	Experimental methods in Nanotribology (I.M. Sivebaek)	Micro/nano production (H.N. Nørgaard)	Project work
01-22	Thursday	Atomic Force Microscope (E. Meyer)		Project work
01-23	Friday	The lubricity of Dimethyl Ether (DME) (I.M. Sivebaek)	Friction of confined polymers (I.M. Sivebaek)	Project work
01-24	Saturday	Social event		
01-25	Sunday			
01-26	Monday	Nanotribological simulations (U. Tartaglino)		Project work
01-27	Tuesday	Nanotribological simulations (U. Tartaglino)		Project work
01-28	Wednesday	Nanotribological contact mechanics (B.N.J. Persson)		Project work
01-29	Thursday	Theory of rubber friction with application to tire-road contacts (B.N.J. Persson)		Project work
01-30	Friday	Project work		Examination

I.M. Sivebaek, Associate Professor, Mechanical Engineering, Technical University of Denmark.

B.O. Jacobson, Professor, Lund University, Sweden.

H.N. Hansen, Professor, Mechanical Engineering, Technical University of Denmark.

E. Meyer, Professor, Department of Physics and Astronomy, University of Basel, Switzerland.

U. Tartaglino, Dr., Pirelli Tires, Milan, Italy.

B.N.J. Persson, Dr., Institut für Festkörperforschung Teori 1, Forschungszentrum Jülich, Germany.