Simulating and measuring the contact mechanics of low-friction patterned surfaces

This project is suitable for two students working together, one experimental and one computational. It is also suitable for individual students working alone or together with students from other departments, or at our collaborators at Trinity College Dublin.

In this project, we will investigate the contact mechanics of patterned surfaces with low-friction coatings. This project is related to structural superlubricity. This is a dramatic effect by which friction is reduced enormously due to structural incompatibility between two surfaces at the atomic level. Macroscopic surfaces in contact in the real-world, however, do not have one large flat contact, but consist of many small contacts.

The goal of this project is to explore different designs for patterning of surfaces that lead to arrays of contacts with specific properties, that will reduce the problematic consequences of surface roughness.

Computational. In the computational part of this project, you will perform numerical calculations of nearly perfect arrays of spherical particles and possibly other structures in contact with each other. You will set up calculations for the deformation in the material using Hertz contact mechanics and other approaches. You will write and perform simulations, and investigate the behaviour of the system. If necessary, you will run simulations on high-performance computing facilities.

Experimental. In the experimental part of this project, you will construct or fabricate macroscopic patterned surfaces using assemblies of ball-bearings and other methods, depending on the shape and materials selection. It will be important to select materials that are suitable for functionalisation of superlubricious coatings using pencilling and other techniques developed by our collaborators at Trinity College Dublin and École Central Lyon. You will design and build an apparatus for performing sliding experiments to measure friction in these systems.

Figure 3: A home made set of patterned surfaces with low friction due to macroscale structural mismatch between the arrays of ball bearings. This device was built by second year undegraduate students in Dublin.

Recommended background

Tribology, basic statistical mechanics, or classical mechanics.

Computational: A basic programming course and an interest in modelling or programming.

Experimental: The experimental student should come from an engineering background and have an interest in material science.

Supervisor

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Research environment: `http://syonax.net/science/research.html`.

Resources

The project may need to make use of high-performance computing resources that are already available through NTNU IT's HPC facilities.

Work load

This project is intended for a combined specialization project thesis and master thesis, i.e. 45 or 60 ECTS in total.