Biomaterials and nanostructured surfaces

Projects available for MTNANO and BIOPHYSICS students

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More information: http://www.ntnu.edu/physics/bionano

1 PROJECT 1

Fabrication of polymer based, patterned, inexpensive superhydrophobic surfaces for bionanotechnology applications.

The main goal of the project is to produce and study substrates with roughness on different length scales to fabricate superhydrophobic surfaces from PDMS and/or other materials commonly used in microfabrication. Cured PDMS is hydrophobic (contact angle 100^o) and the aim is to make its surface superhydrophobic (contact angle higher than 150^o) by control of the surface roughness. In the first instance, the experimental approach will include replica moulding from rough surfaces. Replica moulding will then be combined with lithography to create surfaces with spatially controlled hydrophobicity contrast (superhydrophobic on rough areas and normally hydrophobic or hydrophillic on lithographically defined flat areas).

Figure 1: Lotus flower and its famous superhydrophobic leafs. Bottom - picture of a wet insect showing an example of a surface high water contact angle (source: http://www.nrk.no/vitenskap-og-teknologi/1.8028122)

Superhydrophobic surfaces with hydrophilic spots can be applied to selectively adsorb water (or aqueous solutions containing e.g. salts or microbeads) to the hydrophilic areas. After producing samples with superhydrophobic/hydrophilic contrast, these might also be used in combination with additional standard lithography (e.g. for simple topographic patterns like microchannels) or ice lithography (for wells) to produce simple microfluidic systems or microwell arrays. Depending on results from the 1st experiments, fabrication approaches could also be extended to NIL or other methods (for example colloidal lithography). Characterization will include contact angle measurements and surface characterization using AFM and SEM. This project is a continuation of the project running in 2011/2012, so exact details will also depend on the outcome of the currently ongoing research.

We are looking for motivated and dedicated students interested in nanofabrication and bionanotechnology to work in active and multidisciplinary research group. Due to limited amount of places, student will be chosen based on short interview and grades from the last 2 years of study. Around 75% of the project work will be done in the NTNU Nanlab. Summer job possibilities related to this are also available.

Co-supervisors: Florian Mumm, Department of Physics, NTNU.
NTNU Project student 2012: Brita Melberg (MTNANO);

PROJECT 2

Nanotechnology based cell transfection. From development of the fabrication process to device applications.

Over the past years we worked on the integration of copper oxide nanostructures in devices for physical delivery of material into cells (transfection). The starting point for the project is the fact that dense arrays of copper oxide nanowires are produced when copper foils are oxidized at controlled conditions (see Figure 2). To create a substrate suitable for the transfection of cells, the nanowires are integrated in epoxy-based devices. At present various devices are fabricated and we are in the process of demonstrating that they can be used to deliverer molecules into cells. This project is a continuation of the project running in 2011/2012, so exact details will also depend on the outcome of the currently ongoing research and which aspects of the project is most interesting for the student. It will include the combination of bottom-up (CuO nanowire growth) and top-down (basic UV lithography) fabrication, device characterization by SEM/STEM, and optical, fluorescence and electron microscopy of cells. In addition to device development and cell experiments, we would

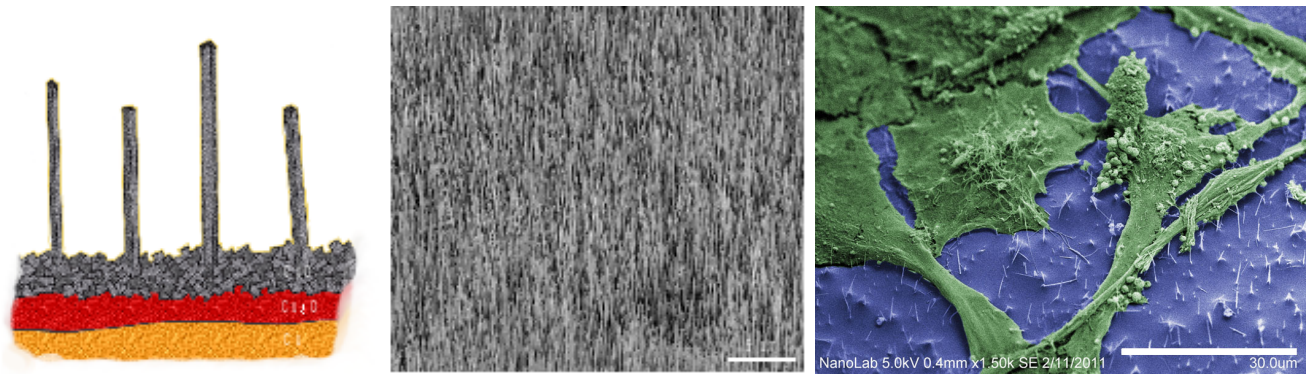

Figure 2: Array of vertically aligned CuO nanowires and sketch of the chemical composition of the substrate. Cells growing on nanowire decorated surface (photo: F. Mumm and K.Beckwith, NTNU)

like to focus on a more detailed description of oxide nanowire growth (using growth at controlled conditions and characterization with SEM and X-ray diffraction).

We are looking for motivated and dedicated students interested in nanofabrication and bionanotechnology to work in active and multidisciplinary research group. Due to limited amount of places, student will be chosen based on short interview and grades from the last 2 years of study. Around 50% of the project work will be done in the NTNU Nanolab. Summer job possibilities related to this are also available.

Co-supervisors: Florian Mumm, Department of Physics, NTNU (mumm@ntnu.no) and Kai Beckwith, Dept. of Physics, NTNU (kai.beckwith@ntnu.no).
Colaboration: Astrid Lægreid, Torunn Bruland, Department of Cancer Research and Molecular Medicine, NTNU

NTNU Project student 2012: Åsmund Flobak (MTNANO)

PROJECT 3

Application of focused ion beam (FIB) and scanning electron microscopy (SEM) for characterization of tissue, cells and biocomposites for tissue engineering applications.

FIB is a promising method for nanometer scale characterization of biological composite materials. The aim of the project is to develop sample preparation methods and imaging techniques suitable for obtaining information regarding 3D organization of tissue and cell samples, as well as composite materials for applications in tissue engineering. Those materials developed mainly for tissue engineering applications are made as a part of larger research effort at NTNU. Cell and tissue samples will be related to research on tuberculosis, a global infectious disease that still claims close to 2 million lives every year. The FIB will be used to further examine the host-pathogen relationship and study granuloma (infectious foci wrapped in dead cell material) in 3D.

This project is a continuation of the project running in 2011/2012, so exact details will also depend on the outcome of the currently ongoing research.

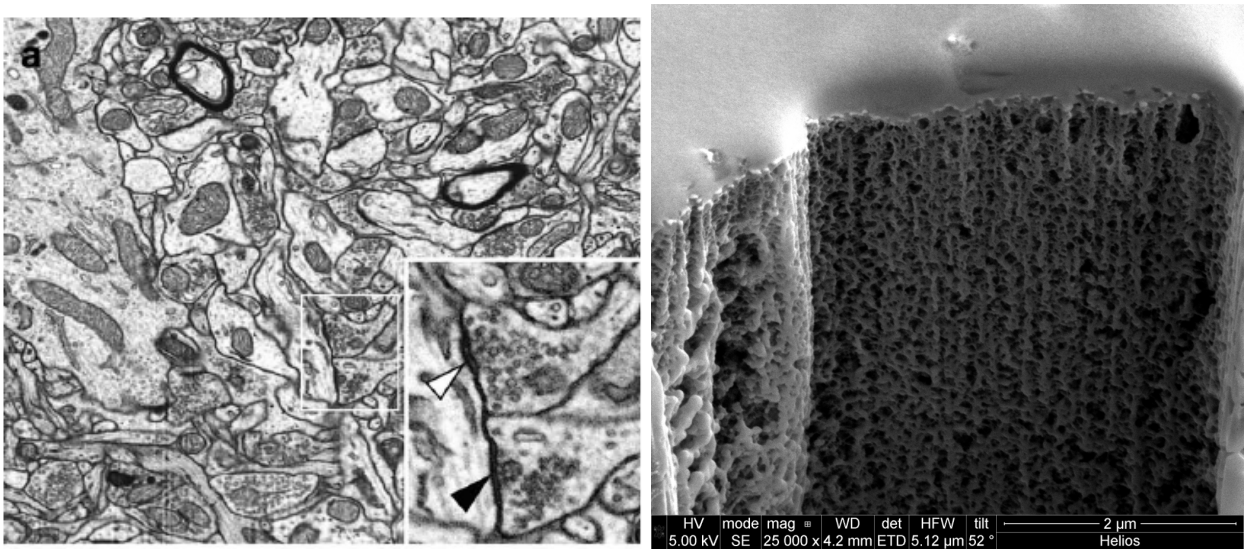

Figure 3: Electron microscopy image of brain tissue sample sliced with FIB (left, Knott et al. J. Neurosci., 2008, 28:2959) and FIB milled hydrogel material (right, photo: Ken Roger Ervik, NTNU).

Project will give good background in microscopic characterization of biomaterials. We are looking for students interested in microscopy (especially electron microscopy) and bionanotechnology to work in active and multidisciplinary research group. Due to limited amount of places, student will be chosen based on short interview and grades from the last 2 years of study. Around 75% of the project work will be done in the NTNU Nanlab. Summer job possibilities related to this are also available.

Co-supervisors: Øyvind Halaas, Department for Cancer Research and Molecular Medicine
NTNU Project student 2012: Marianne Sandvold (MTNANO)