Tunneling nanogap electrodes fabrication by capillary-assisted particle assembly

Semester/Master Project
(Section: microengineering)

Nanogap electrodes (NGEs) comprise a pair of electrically conducting materials separated by a nm-scale air gap. Over past decades, NGEs have been utilized in applications such as molecular detection, nanoantennas, and next generation DNA sequencing. For nanogaps in the < 4 nm regime (so-called tunneling NGEs), the exponential dependence of the tunneling current on the gap width makes NGEs interesting for cases where the tunneling NGEs is mechanically tunable on a stretchable substrate.

In this project, the goal is to fabricate tunneling nanogap electrodes using the technique called “capillary-assisted particle assembly (CAPA)”: as shown in the image below, when the moving meniscus passes over predefined traps, the capillary force inserts Au nanorods into traps while dragging away excessive nanorods on the hydrophobic silanized substrate surface.

Starting with the trap design and the e-beam lithography to fabricate nanoscale traps on the substrate in the CMi, and then conduct sequential CAPA process to assembly nanogap electrodes and study the yield performance with the scanning electron microscope (SEM). Finally, if applicable, another e-beam lithography process to fabricate the metal lead for the tunneling current measurement.
Work description:

- Trap design and GDS preparation
- E-beam lithography in CMi: RIE and lift-off
- CAPA process strategy development and yield study
- Tunneling nanogap electrodes electrical characterization (if applicable)

Contact: Henry Yu (shao-chi.yu@epfl.ch)
Development of a fully-automatic tunable tunneling nanogap electrodes measurement setup

Semester Project
(Section: microengineering, electrical engineering)

Nanogap electrodes (NGEs) comprise a pair of electrically conducting materials separated by a nm-scale air gap. Over past decades, NGEs have been utilized in applications such as molecular electronics, nanoantennas, and DNA sequencing. For nanogaps in the <3 nm regime (so-called tunneling NGEs), the exponential dependence of the tunneling current on the gap width makes NGEs interesting for cases where the tunneling NGEs is mechanically tunable on a stretchable substrate. The electro-mechanical characterization of such tunneling NGEs can be conducted by a measurement setup consists of a tensile stretcher, data acquisition cards, and a current amplifier.

In this project, the goal is to optimize the existing semi-automatic measurement setup into a fully-automatic measurement setup so that more characterizations such as long term cyclic measurement can be conducted without manual handling.
Work description:

- Equipment control via LabView
- LabView program development
- Fully-automatic electro-mechanical measurement testing

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Silicon nanomembrane

Master project / Semester Project

(Section: microengineering, material sciences)

Silicon electronics have been widely used in our daily as many applications. However, the brittle nature of the bulk silicon hinders the achievement in flexible and wearable devices. Silicon nanomembrane, which corresponds to the silicon with nanometer scale thickness has attracted researchers’ attention recently. The intriguing properties of silicon nanomembrane such as the increased flexibility, piezoresistive coefficient, and surface-to-volume ratio enable further developments especially for the wearable devices.

Here, we offer an exciting opportunity to the student to work with this intriguing materials and contribute to broaden the applications. Hence we are looking for a highly motivated student to explore this technology.

Work description:

- Transfer printing of silicon nanomembrane to flexible substrates
- Strain sensing characterization
- Sensing mechanism study

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