ESF Short Visit Grant – Scientific Report

Reference number: 5406

Activity title

New Approaches to Biochemical Sensing with Plasmonic Nanobiophotonics (PLASMON-BIONANOSENSE)

Title of the research project

Implementation of novel off-stoichiometry thiol-ene polymer materials for plasmonics

Applicant's name and address

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Host name and address

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1. Purpose of the visit

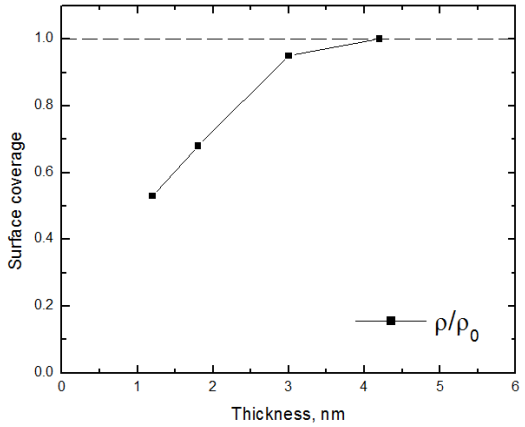
The purpose of the visit was to explore possibilities for collaborative projects between the University of Iceland (UI) and KTH within the field of plasmonics, microfluidics, biosensing, nanophotonics and/or any combination of these fields, all of which are being actively pursued at both institutes. Specifically, the possibility of incorporating novel polymer materials (off-stoichiometry thiol–ene, OSTE) developed by the KTH host team [1,2], into a nanoplasmonic platform for microfluidic/sensing purposes. The polymer has been developed as an alternative to the conventional PDMS silicone material widely used for microfluidics . PDMS has a range of problems, particularly related to porosity and the uptake of fluorescent dyes into the silicone matrix, which disturbs measurements carried out over long time scales and makes actual conditions, such as pH, inside the microfluidic system uncertain and dependent on the outside conditions. Furthermore, several cell lines have been shown to behave differently when cultured on a PDMS surface, as compared to conventional polystyrene or glass culture dishes. The search for more suitable materials for molding and bonding of microfluidic circuits is therefore of primary importance. Furthemore, the KTH material is of particular importance for plasmonics, as it has a natural affinity to gold.

2. Description of the work carried out during the visit

Work carried out during the visit consisted of meetings with different KTH group members, a presentation of the activities of the UI group, laboratory visit to the cleanroom fabrication facilities in Kista, and a practical introduction to the preparation of OSTE polymers, as well as molding and patterning techniques. Plans for immediate collaborative projects were made, including gold depositions on OSTE surfaces with excess thiol groups to investigate the dynamics of Au film formation during deposition and compare with other optical polymer materials using x-ray techniques [3].

3. Description of the main results obtained

Initial testing of the OSTE polymer has confirmed that it exhibits a performance superior to other materials investigated by the UI group, in terms of inhibiting spontaneous island formation in ultra-thin gold films. XRR surface coverage measurements reveal that perfectly dense Au films as thin as 4 nm are observed after deposition onto an OSTE surface with 60-70% excess thiol (see graph). In comparison, the Au deposition thickness required for realizing continuous films on glass substrates is 12-15 nm [3].



Work on increasing further the excess thiol concentration on the surface has started but further optimization still has to be carried out. A direct follow-up of these findings will be the measurement of optical transmission through the Au films, in order to establish the presence or absence of optical extinction related to structural irregularities in the film.

4. Future collaboration with host institution (if applicable)

Several possibilities for future collaboration with the host institution have been outlined. The fabrication of microfluidic devices [1] incorporating metal films (e.g. for SPR imaging) or metal nanostructures (e.g. for Raman scattering) will commence a.s.a.p., after initial tests of Au film formation on the OSTE polymer have been completed. As more complex device geometries can follow, it is likely that a collaboration will continue for a couple of years, at least, with possibilites of student/postdoc exchanges already drafted.

5. Projected publications / articles resulting or to result from the grant

The immediate results of the project will be incorporated into a paper which is in preparation, in collaboration with S. Maier‘s group at Imperial College. Future papers on plasmonic components in OSTE microfluidic devices can also be expected, possibly later this year.

References

[1] Lab Chip, 2012, 12, 3032–3035
[2] Lab Chip, 2011, 11, 3136
[3] Nanophotonics, DOI 10.1515/nanoph-2012-0030