ESF Short Visit Grant – Scientific Report

Reference number: 6125

Activity title

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

Title of the research project

Design and study of metallic nanostructures for surface-enhanced Raman scattering applications

Applicant's name and address

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Host name and address

Prof. Kristjan Leosson, Science Institute, University of Iceland, Dunhagi 3, IS 107 Reykjavik, Iceland

1. Purpose of the visit

The purpose of the visit is to design and study metallic nanostructures for surface-enhanced Raman scattering (SERS) applications in collaboration with researchers at the University of Iceland. The proposed structures consist of specially patterned gratings for simultaneous coupling and superfocusing of slow plasmons on a polymer-gold-water interface. Researchers at the host institute have expertise in fabricating polymer-based photonic devices, including devices designed specifically for index-matching to biological solutions and devices with nanoscale metallic features and microfluidic integration. Relevant structure designs will be modelled using finite-difference time-domain software, in order to guide fabrication efforts. Structures fabricated by electron-beam lithography at the host institute will be characterized by SERS, both at the host institute and at the Humboldt University in Berlin. In the present project, the host institute benefitted from the applicant's experience in numerical modelling, plasmonics and microfluidics.

2. Description of the work carried out during the visit

Work carried out during the visit consisted of meetings with different group members at the University of Iceland, laboratory visit to the cleanroom fabrication facilities in University of Iceland, e-beam lithography facility at the Iceland Innovation Center. Novel polymer-gold plasmonic nanostructres were fabricated by using e-beam lithography and were modelled numerically using the Finite Difference Time Domain technique.

3. Description of the main results obtained

Finite Difference Time Domain (FDTD) simulation results reveal for light polarized perpendicular to the gap strong field concentration. An easy fabrication technique for building a microfluidic chamber to incorporate the nanostructures were constructed. Testing reveal excellent performace of the device. Intial nanostructre fabrication testing were partially sucessful. The testing reveal good adhesion between the gold layer and the polymer, but the e-beam dosage still need to be optimized for current geometry and especially to account for the CYTOP / Si architecture.

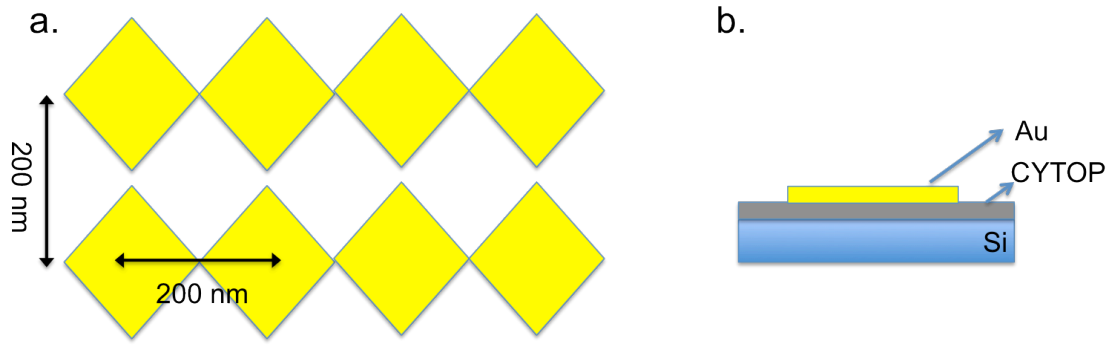

Fig. 1: Illustration of the design fabricated (a) top view and (b) cross section

Work on optimizing the fabrication procedure has already begun. A direct follow-up of current findings will be the measurement of optical transmission through the nanostructures, in order to establish the presence or absence of optical extinction related to the design and using the data to setup a SERS measurement.

4. Future collaboration with host institution (if applicable)

Several possibilities for future collaboration with the host institution have been outlined. For example, the gap between the nanostructures can further be narrowed using electromigration technique which will result in greater enhancement of the Raman signal. It would be interesting to continue the collaboration with the host institution to make further investigations along these lines. In addition, the host institute has a wide range of x-ray characterization tools which may be used to monitor changes in the crystal structure of the gold particles (also at elevated temperatures). It is clear that annealing significantly improves the crystallinity of the patterned particles, with positive effects on their plasmonic properties.

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

Future papers on plasmonic components in SERS microfluidic devices can also be expected, possibly early 2014.

6. Other comments

The applicant would like to thank Prof. Kristjan Leosson for the oppurtunity and gratefully acknowledges his assistance.