ESF Funding Report for Dr. Yang Zhang's visit to Prof. Joachim Krenn's group in Graz

1 Purpose of the visit:

The goal of this visit was to acquire the appropriate knowledge of sample fabrication and leakage radiation spectroscopy so as to apply this knowledge to nanostructure luminescence experiments carried on our scanning tunneling microscope (STM) excitation setup, and pave the way for our future research on biochemical sensing with plasmonic nanostructures.

2. Description of the work carried out during the visit;

The work carried out during the visit included:

1) Discussion on the results from Au nanostripes and related simulation.

2) 30nm-thick ITO film growth on glass.

3) Design and fabrication of Au nanowire arrays with area-selectively deposited quantum dots.

3. Description of the main results obtained;

1) Discussion on the results from Au nanostripes and related simulation.

During my stay in Prof. Krenn's group in Graz, I took part in their experiments on Quantum dots emission. I learned more about leakage radiation microscopy and discuss some problems in previous experiments.

Using STM excitation technique, we find photon emission pattern differences on Au nanostripes with air objective and oil objective, as shown in Fig. 1(a) and (b). In air objective images, only four light emission spots are observed, while photon emissions are detected all along the Au nanostripe in oil objective images. Through discussion and simulation, we better understand the phenomena and found out that the difference originates from the propagating surface plasmons scattering into large angles when hitting the nanostirpe edge at large angles of incidence. The simulation results fit well with our experimental images.

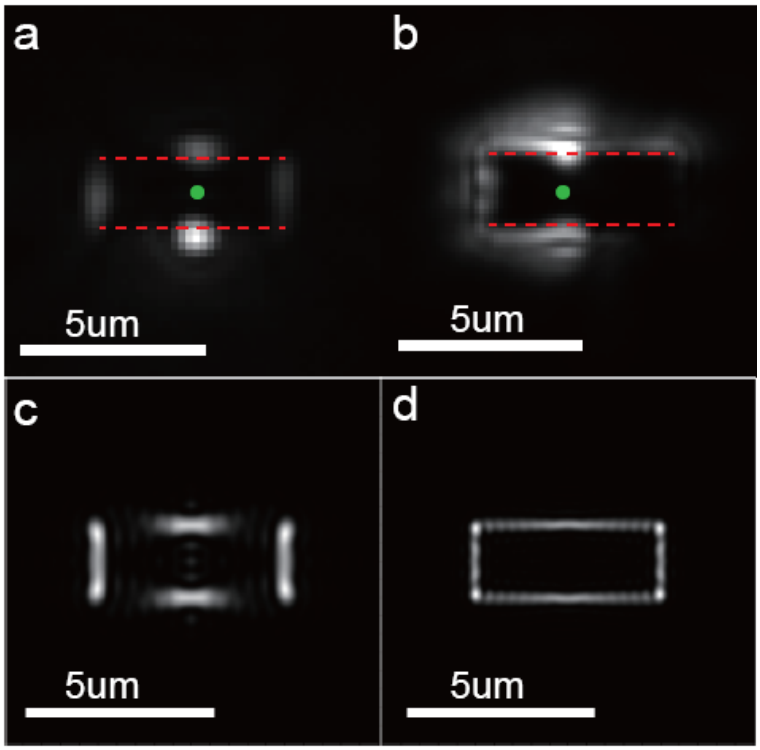

Fig. 1 (a) (b) experimental images acquired with an air objective (NA=0.95) and an oil objective (NA=1.45). Green circles indicate the excitation position of STM tip. Red dotted lines indicate the profile of Au nanostripe. (c) (d) Simulated microscopy images of the edge scattering from a SPP excited in the center for (c) NA=0.9 and (d) NA=1.45.

2) 30nm-thick ITO film growth on glass.

A flat, transparent and conductive surface is essential for STM induced luminescence measurement. The ITO film sample is transparent as shown in Fig. 2(a). The surface of ITO film is flat and suitable for STM scanning, as no large ITO grains are observed in Fig. 2(b).

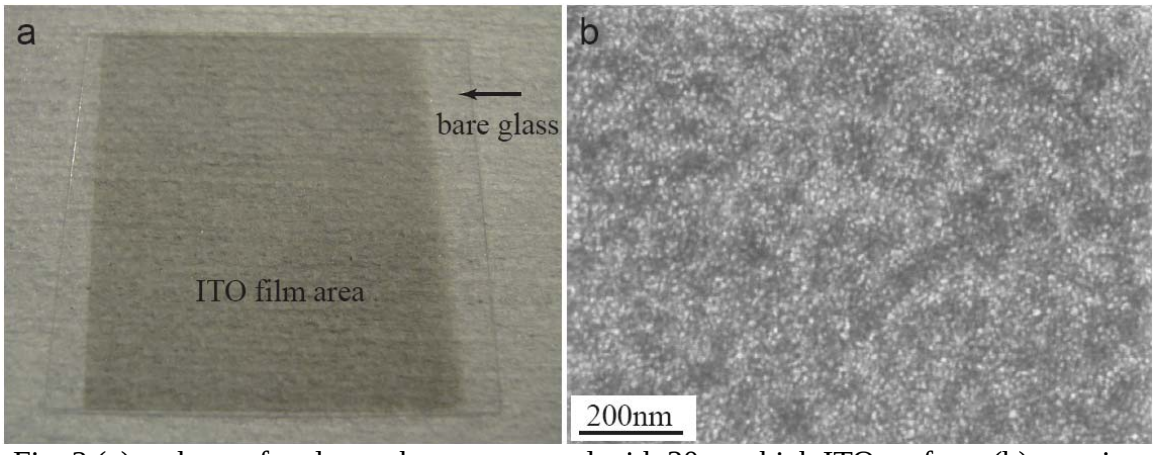

Fig. 2 (a) a photo of a glass substrate covered with 30nm-thick ITO surface. (b)scanning

electron microscope image of a typical surface area of 30nm-thick ITO film deposited on glass substrate.

3) Design and fabrication of Au nanowire arrays with area-selectively deposited quantum dots.

Au nanowires are important plamon guiding structures in a plasmonic circuit. Energy and information can transferred with propagating surface plasmons on nanowires. By combining the Au nanowires with quantum dots and exciting quantum dots emission by propagating surface plasmons, we could perform plasmonic nanoscale addressing. As shown in Fig. 3, quantum dots are selectively deposited close to nanowire ends.

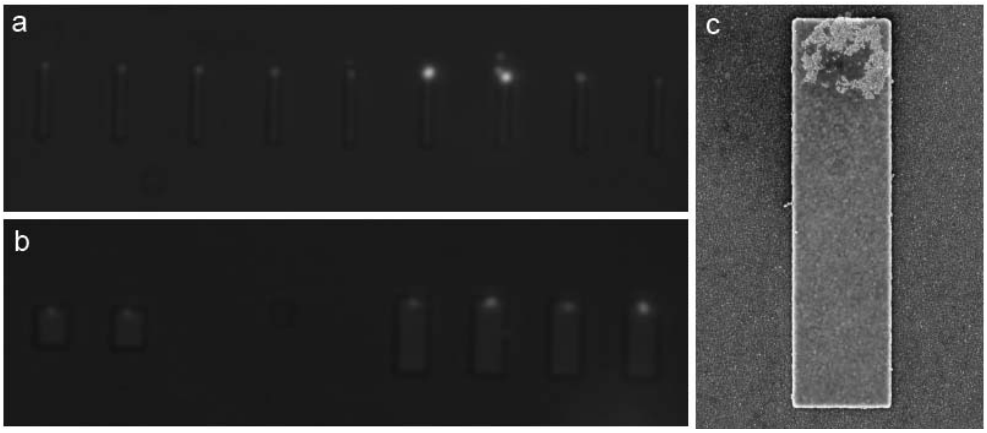

Fig. 3 (a) (b) photon emission image of quantum dots close to Au nanowire ends (different widths) excited by 488nm laser. (c) scanning electron microscope image of a Au nanowire with quantum dots selectively deposited close one end.

4. Future collaboration with host institution (if applicable);

Yes, we will continue collaborating with Professor Krenn's group.

5. Projected publications / articles resulting or to result from the grant (ESF must be acknowledged in publications resulting from the grantee's work in relation with the grant);

Propagating surface plasmon emission from Au nanostripes excited by tunneling electrons, in preparation

6. Other comments (if any).

Thanks to Professor Krenn's group and the ESF for this opportunity.