Research Networking Programmes

Short Visit Grant ☒ or Exchange Visit Grant ☐

(please tick the relevant box)

Scientific Report

The scientific report (WORD or PDF file – maximum of eight A4 pages) should be submitted online within one month of the event. It will be published on the ESF website.

Proposal Title: New Low Loss optical metamaterials

Application Reference N°: 6786

1) Purpose of the visit

Scientific visit to the spectroelectrochemistry laboratory of Prof. Holze at the University of Chemnitz, Germany for discussion about possible joint investigations on surface-enhanced spectroscopies and related topics.

2) Description of the work carried out during the visit

Over the past several years the field of plasmonics has seen enormous growth due to the ability to manipulate light on the nanoscale for applications in areas such as subwavelength photonics, light emitters, and sensing. The conventional materials for plasmonics, metals, however suffer from high losses and heating effects which are detrimental to applications in nanophotonics and sensing where the materials under interest can be damaged by the intense local heating.

During this visit to the group of Prof. Holze, I had the chance of interacting with several experts in fabrication and characterization of all kind of materials (plasmonic and non-plasmonic). I gave a seminar to describe in detail the problem of the actual materials that are often employed in surface enhanced applications and to propose possible alternatives to overcome these problems. After several discussions, and careful study of my theoretical results, several possible experiments were proposed to proof that it is possible to improve the actual surface enhance spectroscopies by replacing the actual metallic nanoantennas by low-loss dielectric ones. In this way, we can reach high near and far field enhancements, together with the ability to locally manipulate both the electric and magnetic fields while exhibiting low heating.

3) Description of the main results obtained

I had the chance of discussing with several members of the Chemnitz lab group about novel approaches to achieve control of near- and far-field electric and magnetic properties of nanostructures at optical frequencies based on the use of low-loss high-refractive index dielectrics, as novel materials sustaining not only electric but also magnetic resonances in the optical regime.

We discussed several particular situations where I focused on the theoretical ideas and they provided with very useful ways about how to experimentally characterize the possible new structures.

This visit is expected to give rise to novel and original EM phenomena with outstanding technological potentials. For instance, big efforts are currently been paid without success to emulate basic electronic circuit components by means of optical nanostructures addressed to the development of a future optical computer. Here is where directionality can play a fundamental role. Except for very few recent studies, exploring these all-dielectric magnetic nanoantennas as building blocks of metamaterials able to exert control over the electric and magnetic near field enhancements, and the far field directionality of the scattered light, is today a virtually unexplored territory, but presumably, a very active topic in the next few years. In this sense we discussed the possibility of using magnetic counterparts of the electric dipolar emitters as prospective probes of the magnetic components of light or the magnetic local density of states (m-LDOS). We also found that , by accessing the magnetic resonances in single dielectric nanoantennas, we obtain a versatile control of the m- LDOS and thus of the radiative properties of such emitters. Finally we discussed the possibility of using novel hybrid structures (MD/Metal) aiming to design and fabricate them in a way that can make accessible the strong magnetic hot spots that MD materials generate in its interior. This control of the magnetic field enhancement at optical frequencies could open new possibilities for local magnetic spectroscopies, electric and magnetic sensing at the nano scale or light guiding.

4) Future collaboration with host institution (if applicable)

We will keep collaborating via email and once the project gets a bir further we will plan a next meeting.

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)***

6) Other comments (if any)