The main purpose of my visit to Prof. Maier’s Group was to interact with the experimental part of the group to tackle experimentally the theoretical models I worked on for developing new optical metamaterials that may overcome the problem of the losses in the current metamaterials. In particular, we tried to merge concepts of the electric and magnetic response to study the properties of basic magnetic emitters in interaction with antenna dimers and small collections of basic structures made of high refractive index dielectric materials with low losses.

The initial objective of this project was to study different materials (Ge, Si, GaP, GaAs and few others), matching the aforementioned properties, to identify which of them could be used in the fabrication of structures that may act as low loss electric and magnetic antennas.

It appeared that although Silicon could be ideally the best, it was not possible to fabricate it at the required range of sizes. Germanium although quite lossy below 1µm, could still be exploited for enhancing fields at larger wavelengths thus being useful for SEIRA. Finally, we focused on GaP, finding that it can be a serious competitor to metallic materials, offering extremely low losses, good enhancement and the possibility of controlling its scattering directionality in a broad spectral range.

Once the adequate material was found several simulations were performed in order to optimize the size and shape of the structure that may offer optimal field enhancement and best far field propagation.

Meanwhile the theoretical study was carried out, discussions with the experimental part of the group were carried out in order to see wether fabricating the proposed material was feasible or not and also to work on the design of an experiment to prove that the aforementioned structures made of such material could provide with the expected low loss antenna properties.

All the theoretical studies where based on numerical studies performed with use of finite-difference time-domain software (Lumerical) and COMSOL multiphisics. These numerical methods although are broadly established in computational electromagnetism to calculate the optical response of different nanostructures they are not optimized, especially when there is the presence of substrates or if the incidence is not normal, thus we had to develop few models to tackle the presence of the substrate and the possible tilting of incidence.

Although the main theoretical results have already been obtained, there is still some more work to do on them. Also remark that the experiment based on the GaP requires additional time to be finished, but a working planning was established for this, so these results can end up also in an interesting publication.

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Also mention that during this stay I had several scientific discussions in connection with the field of nanophotonics, which have led to several new ideas that will be studied further in a close future.

In summary, this visit to Prof. Maier's lab, apart from offering me the possibility of getting introduced to advanced experimental techniques, it allowed me to have several scientific discussions in connection with the field of nanophotonics, which have led to several new ideas that will be studied further in a close future.

helped me to develop further our collaboration regarding the use of nanoantennas for biosensing and optical switching (e.g. waveguide sensors, new design, tuneable sensors), which can provide a unique platform to obtain high-impact results.