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PhD THESIS DEFENSE: Controlling the strong interaction between quantum emitters and plasmonic rod-dimers.

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The growth of technology and climate change have increased the need for more efficient, biodegradable and ecologically sustainable electronic devices. With this in mind, different methods have emerged to improve the performance of organic materials. In particular, the union of plasmonic nanostructures with quantum emitters marked a new line of device research. The interaction between plasmons and quantum emitters led to the modification of the chemical properties of quantum emitters, which helped improve the absorption and emission capabilities of molecules. However, despite the efforts employed, reliable platforms to study the interaction between plasmons and molecules reproducibly have not yet been developed. This thesis aims to increase the interaction strength between plasmonic structures and organic molecules in a reproducible fashion by varying the optical properties

of metallic structures. A fluorescent dye and a protein belonging to a photosyntheti bacterium were chosen as the systems to study. Consequently, the properties of th structures were tailored to obtain the desired optical response that matched th molecules/protein of interest. Mainly, the plasmonic structures' material, shape and siz served to modify the resonance frequency and intensity of the near-field of the plasmon. I particular, this thesis investigated the plasmon interaction volume's effect on achieving an increasing the coupling strength. Fabrication of antennas by lithography, therma evaporation, and helium ion milling allowed these properties to be modified. Nanorod dime fabrication decreased the modal volume to less than 10 nm resolution. Characterising th structures was very important since the fine-tuning of the dimers led to different results Here, darkfield confocal microscopy was used to analyse the plasmonic dimers' spectra response. In addition, finite difference time domain (FDTD) simulations provided informatio on the near-field strength in the dimer feeding space. Later, the molecules to th nanoantennas extended the study to coupled systems. Some systems showed a stron interaction between the dimers and the molecules/protein, which was identified by the mod splitting of the scattering spectra, the dispersion relation, and a comparison betwee coupling strength and individual system losses

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