Controlling light and heat at the nanoscale

Pablo Albella
J. González-Colsa, G. Serrera, J. M. Saiz, D. Ortiz, F. González, F. Bresme, F. Moreno

Department of Applied Physics (Optics Group)
University of Cantabria, Santander 39005, Spain

Pablo.albella@unican.es

Abstract

Plasmonic nanoantennas have shown as a versatile tool to control light beyond the conventional diffraction limit. They are known to suffer relatively large losses and consequently the Joule heating of the structure and its local environment. On the other hand, nanoparticles made of High Refractive Index (HRI) dielectric materials, such as Si, or other semiconductors have been proposed recently as an alternative to metals, driven by their low-losses and presence of magnetic response in spite of being non-magnetic materials [1]. In the first part of the talk I will introduce the basics and some advances of this recent topic of dielectric nanophotonics, discussing some recent results[1] that are boosting its progress. Special attention will be paid to applications like directional control or light diodes [2-4] (see fig 1), optical switching [5], beam steering [6], surface enhanced spectroscopies [7], enhancing chiral sensing (see fig. 2) [8,9] or non-linear optics[10]. The second part of the talk will be framed in the topic of thermoplasmonics and dedicated to the design of efficient nanoheaters and to discuss novel ways to control the heat delivery in photothermal applications [11].

References

[1] Barreda, A. I. et al. AIP Advances 2019, 9 (4), 040701
[2] Geffrin, J. M. et al. Nat. Commun. 3, 1171 (2012).
[3] Shibanuma, T. et al. Nanoscale 2016, 8, 14184-14192
[4] Shibanuma, T. et al. Appl. Phys. Lett. 112, 063103 (2018)
[5] Barreda, A.I. et al. Nature comms. 2017, 8 (1), 1-8.
[6] Shibanuma, T. et al. ACS Photonics 2017, 4, 489.
[7] Caldarola, M. et al. Nat. Commun. 2015, 6, 7915.
[8] Reyes-Gomez, F. et al. ACS Omega 2019, 4, 25, 21041-21047.
[9] Reyes-Gomez, F. et al. Phys.Rev. B 2020, 101, 155403.
[10] Shibanuma, T. et al. Nano Lett. 2017, 17, 4, 2647-2651.
[11] Gonzalez-Colsa, J. et al. arXiv:2106.01059

Figures

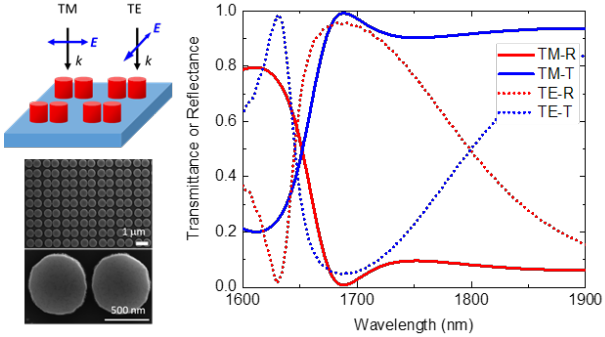

Fig. 1: Transmission and reflection of a Si dimer array for TM (solid) and TE (broken) polarization.

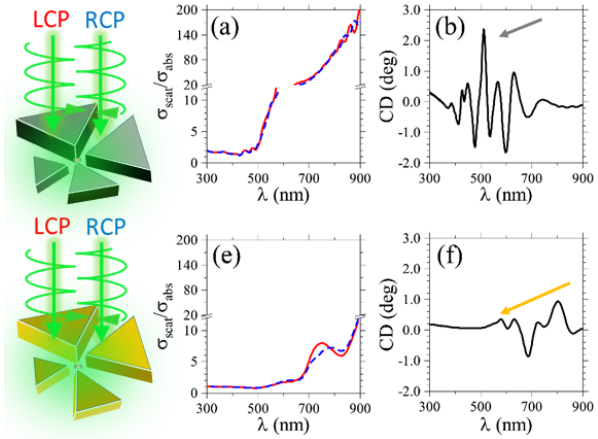

Figure 2: Scattering to absorption ratio and CD spectrum, for systems made of Si and Au.

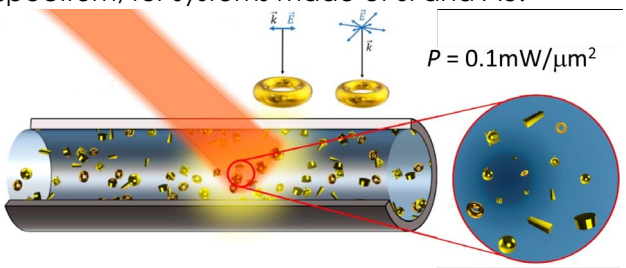

Figure 3: Standard thermofluidic application. Upon excitation by light, an effective local temperature increase will correspond to an average temperature of all possible orientations [see ref. 11]