Electromagnetic simulation of the optical response of metal bowtie nanoantennas (using COMSOL Multiphysics)

Introduction. Nowadays photonic devices are mainly composed of dielectric materials with positive dielectric permittivity. However, dielectric media are diffraction limited and do not allow the localization of electromagnetic fields at the nanoscale. By contrast, the collective excitations of conduction band electrons in metal-like materials with negative dielectric permittivity, also known as *surface plasmons*, allow achieving localization of electromagnetic energy into nanoscale volumes [1-5]. For instance, the excitation of surface plasmons leads to extreme localization of the electromagnetic field (near-field and far-field) with resonances located in optical range from ultraviolet over the visible to the near-infrared. A great advantage of plasmonic materials is due to their *tunable* optical properties meaning that their electromagnetic response can be controlled through the size, shape, composition, and dielectric environment of structures [6]. In this context, metal nanoparticles are very attractive as they can be used for applications in optics, solar cells, bio-sensing for detecting biological molecules, magneto-optical data storage, and information processing.

Objective: Calculate optical response of metal bowtie nanoantennas by using a numerical Finite Element Method (Comsol Multiphysics). Students will simulate the interaction of the bowtie nanoantennas of different sizes with electromagnetic waves and calculate their optical spectra, near- and far-fields. The effect of dielectric substrates on the optical response of nanoantennas will be studied.

References:

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