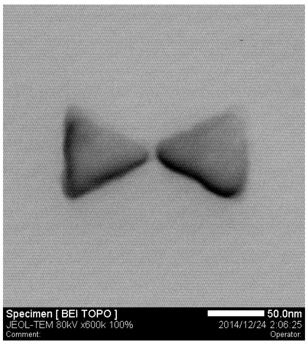
# Modeling the optical response of metal bow-tie nanoantennas

**Introduction.** Nowadays photonic devices mainly composed of dielectric materials with positive dielectric permittivity. However, dielectric media are diffraction limited and do not allow the localization of electromagnetic fields into nanoscale regions. 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 regions [1-5]. For instance, the excitation of surface plasmons leads to extreme localization of the electromagnetic field (near-field and far-field) with resonances that happen to be 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, the 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:** Calculation the optical response of metal bow-tie nanoantennas by using the numerical Finite Element Method (Comsol Multiphysics). In particular, students will simulate the interaction of the bow-tie nanoantennas with external sources such as electromagnetic waves and dipole emitters.




**Tasks:**

- Read articles related to the subject. Study the basic of the Finite Element Method and the electromagnetic module (RF) of COMSOL-Multiphysics.
- Simulate the interaction of metal nanoantennas with *plane wave* and *point dipole*. Calculate their optical response (optical cross sections, near- and far-fields, and photonic local density of state).
- Study the effect of substrate permittivity.

**References:**

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