Fano resonances in plasmonic nanostructures: modelling, large-area fabrication and applications

Benjamin Gallinet CSEM Muttenz, Switzerland

With their ability to concentrate light at a deep subwavelength scale by excitation of surface plasmons, metallic nanostructures play a major role in current nanoscience. Plasmonic modes with long radiative life times can drastically enhance the performance of nanophotonic devices. Their spectral response carries an asymmetric line shape with sharp spectral features, characteristic of Fano resonances. Insightful modelling and up-scalable fabrication of Fano-resonant plasmonic nanostructures is reported.

The optical properties of such complex plasmonic resonators can be modelled by interacting classical oscillators and analytical formulae, which are powerful tools for understanding and predicting their behaviour (B. Gallinet, T. Siegfried, H. Sigg, P. Nordlander, O.J.F Martin, *Nano Letters*, **13**, 2013, pp 497-503). In a system with coupled antennas, it is theoretically and experimentally demonstrated that Fano resonances can be obtained by destructive interference between two bright dipolar modes out of phase. The plasmonic equivalent of a bound state in the continuum is observed (A. Lovera, B. Gallinet, P. Nordlander and O. J. F. Martin, *ACS Nano*, **7**, 2013, pp. 4527-4536).

In order to push the transfer of Fano-resonant nanostructures towards the industry, the development of up-scalable fabrication methods is necessary. The manufacturing by nanoimprint lithography of large–area complex plasmonic devices is demonstrated. The plasmonic nanostructures are manufactured by patterning a sol–gel material and evaporating a thin metallic layer. Angular evaporation is used to provide a shape analogous to split–ring resonators to the nanostructures. A Fano resonance arising from the interaction of high order plasmonic modes is observed.

Thanks to their unique optical properties, Fano-resonant systems can be implemented in a variety of applications. The particular topics of biosensing (B. Gallinet and O. J. F. Martin, *ACS Nano*, 7, 2013, pp. 6978-6987) and structural colors are discussed.