Plasmonics: From materials to metasurfaces in the linear and nonlinear regimes

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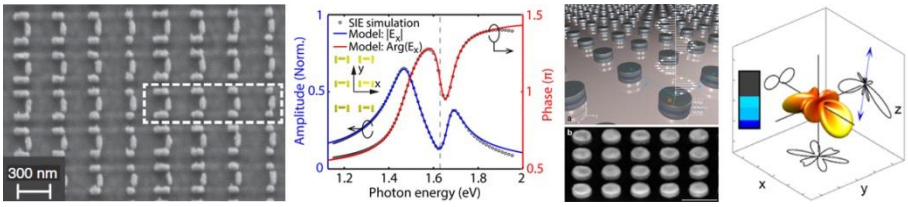
In that presentation, I will highlight some facets of our recent work on plasmonics. A comprehensive study of plasmonic nanostructures requires mastering complex numerical simulations (the electromagnetic field can span several orders of magnitudes over a few nanometers at the surface of a plasmonic nanostructure), nanofabrication (typical features must be controlled down to about 10 nm) and optical characterization in the linear and nonlinear regimes.

While gold has been the metal of choice for plasmonics – mainly due to its ease of fabrication – novel materials are emerging, especially silver and aluminum, which are less lossy and can be used at shorter wavelengths than gold. The fabrication of silver and aluminum nanostructures is quite challenging and I will present some simple recipes that can achieve high quality nanostructures. I will also show that – contrary to a widespread belief – it is possible to fabricate nanostructures in silver that do not deteriorate for months in ambient conditions.

Through appropriate design, it is possible to build nanostructures which optical response exhibits a strong phase shift with respect to the illumination. Such structures, fabricated in silver and aluminum will be used to build metasurfaces that exhibit extraordinary optical responses, including color-selective routing and a very strong nonlinear response, thanks to the utilization of multi-resonant nanostructures or the utilization of surface waves supported by the metasurface. Finally, I will show how the concept of Eddy current – well known in classical electromagnetism – can be used to design and fabricate plasmonic nanostructures that do not get hot, one of the major drawbacks of plasmonics.



Olivier J.F. Martin is Professor of Nanophotonics and Optical Signal Processing at the Swiss Federal Institute of Technology, Lausanne (EPFL), where he is head of the Nanophotonics and Metrology Laboratory and Director of the Microengineering Section. He conducts a comprehensive research that combines modelling with nanofabrication and experiments on plasmonic systems, with applications in nonlinear optics, biosensing, security features and optical manipulations at the nanoscale. Dr. Martin has authored over 250 journal articles and holds a handful of patents and invention disclosures. In 2005 he introduced the concept of an optical antenna, which is now widespread in plasmonic; in 2016 he received an ERC Advanced Grant on the utilization of plasmonic forces to fabricate nanosystems.