Plasmon-mediated chemical surface functionalization at the nanosocale

I. Kherbouche[1], I. Tijunelyte, M. Nguyen[1], N. Ldigi-Guigui, S. Lau-Truong, G. Lévi, J. Aubard[1], J. Grand[1], L. Boubekeur-Lecaque[1], M. Lamy de la Chapelle[2], C. Mangeney[1], N. Félidj[1]
Interfaces, Traitements, Organisation et Dynamique des Systèmes, Université Paris Diderot, Sorbonne Paris Cité, CNRS UMR 7086, 15 rue Jean de Baïf, 75205 Paris Cedex 13, France

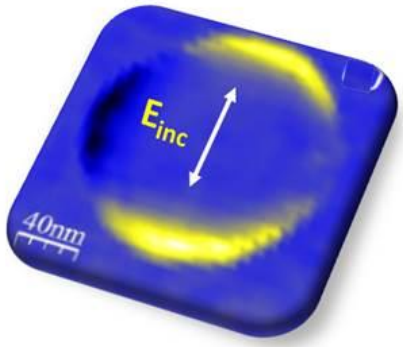
Abstract:

We performed a selective chemical surface functionalization at the nanoscale mediated by localized surface plasmon (LSP) excitation. The surface functionalization is demonstrated through aryl film grafting (derived from a diazonium salt), covalently bound at the surface of gold lithographic nanoparticles (Fig. 1). The aryl film is specifically grafted in areas of maximum near field enhancement, as confirmed by numerical calculation based on the discrete dipole approximation method - DDA (Fig. 2). This selective grafting is attributed to hot electrons generation, which escape from the plasmonic structures and reduce the diazonium salts forming aryl radicals which attach the surface through covalent bonds. Moreover, we show that the aryl film thickness can be monitored by the energy of the incident light as well as the LSP wavelength.

This robust and versatile strategy of nanoscale surface functionalization opens us the route to a controlled growth of additional species such as polymer brushes or quantum dots with high lateral resolution, which is particularly interesting in the context of molecular sensing or nanoscale color-coded devices.

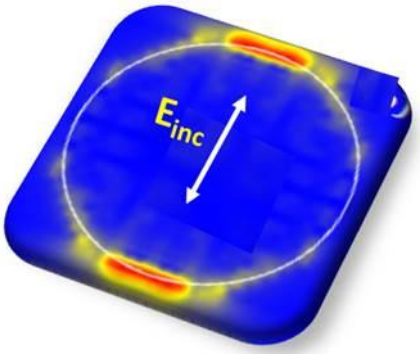
Keywords: plasmonics, surface chemical functionalization, diazonium salt, lithographic structures

Figure 1 :



Differential AFM image of a gold lithographic nano-disc, after plasmon induced grating of an aryl film. The grafting is exclusively located at areas of maximum field enhancement, confirmed by DDA simulations.

Figure 2:



Mapping of the electric field on a gold disc, calculated by the DDA method.

References:

1- M. Nguyen, A. Lamouri,C. Salameh, G. Lévi, J. Grand, L. Boubekeur-Lecaque, C. Mangeney and N.Félidj, *Nanoscale*, 2016,8, 8633-8640.
2. M. Nguyen, and N.Félidj, C. Mangeney *Chem. Mater.*, 2016, 28 (11), pp 3564–3577.
3- M. Nguyen, X. Sun, E. Lacaze, P. M. Winkler, A. Hohenau, J. R. Krenn, C. Bourdillon, A. Lamouri, J. Grand, G. Lévi, L. Boubekeur-Lecaque, C. Mangeney, N. Félidj *ACS Photonics*, 2015, 2, 1199–1208.