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Self-assembled dichroic plasmonic nanostructures: From chains to nanowires

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Keywords: low-energy ion-beam sputtering, oblique-angle deposition, localized surface plasmon resonance, surface-enhanced Raman scattering, second-harmonic generation

Abstract: Recent applications of noble and non-noble metal nanostructures with tunable plasmonic properties (e.g. in nanoscale photonics, photovoltaics, imaging, sensing, biology and medicine, etc.) demand a full control of their morphology (size and shape), organization, and composition over large areas up to several tens of cm². However, still to this day, technical challenges make it difficult to achieve the production of self-assembled plasmonic nanostructures using high-throughput lithography-free methods. Indeed, self-organization approaches including PVD growth and solid-state dewetting of metal thin films suffer from inherent limitations to generate randomly oriented or highly directional dichroic nanostructures at low adatom mobility or high adhesion coefficient. This is especially the case for aluminum and refractory transition metal nitrides, which have recently emerged as promising alternatives to conventional, noble metal-based plasmonic materials such as Ag and Au.

In this presentation, we will show that periodic nanoripple patterns produced by low-energy ion-beam sputtering of insulating surfaces can be used as templates to fabricate self-aligned nanoparticles and nanowires by oblique-angle deposition of Ag [1,2], Au [3], Al [4], TiN or ZrN [5]. Based on experimental and numerical investigations of their far-field and near-field behavior, we will show that these systems possess original dichroic properties, reflected in a polarization-dependent excitation of their surface plasmon resonances, which might be tailored and exploited for various applications such as surface-enhanced Raman scattering [2] or second-harmonic generation [5].

Selected Publication:

[1] L. Simonot, F. Chabanais, S. Rousselet, F. Pailloux, S. Camelio, D. Babonneau, Evolution of plasmonic nanostructures under ultra-low-energy ion bombardment, *Appl. Surf. Sci.* 544 (2021) 148672

[2] S. Camelio, D. Babonneau, E. Vandenhecke, G. Louarn, B. Humbert, Linear chains of Ag nanoparticles embedded in dielectric films for SERS applications in analytical chemistry, *Nanoscale Adv.* 3 (2021) 6719–6727

[3] E. Soria, P. Gomez-Rodriguez, C. Tromas, S. Camelio, D. Babonneau, R. Serna, J. Gonzalo, J. Toudert, Self-assembled, 10 nm-tailored, near infrared plasmonic metasurface acting as broadband omnidirectional polarizing mirror, *Adv. Opt. Mater.* 8 (2020) 2000321

[4] A. Fafin, S. Camelio, F. Pailloux, D. Babonneau, Surface plasmon resonances and local field enhancement in aluminum nanoparticles embedded in silicon nitride, *J. Phys. Chem. C* 123 (2019) 13908–13917

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