Multi-axial Evaporation trhough Nano-Hole Masks: a 3D-printer for the nanoscale

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Abstract

Nowadays we are witnessing breakthrough discoveries in science that improve our understanding of nature and put forward promising practical realizations. These discoveries very often benefit from nanofabrication techniques that allow obtaining sophisticated materials systems whose properties can be designed by structural and compositional control atdavid the nanoscale, making possible the exploration of novel physical phenomena unattainable up to day. Light-matter interaction is not an exception of this and, for example, magnetic field control and enhancement of this interaction have been demonstrated in nanosystems where building blocks with plasmonic and ferromagnetic properties coexist [1]. To give an example, by embedding a ferromagnetic nanodisk in a plasmonic ring and locating it below the hot spot of a plasmonic split ring, a three fold enhancement of the magnetooptical activity of the system can be achieved [2].

In this contribution we will show our developed strategy, based on the Hole Mask Colloidal Lithography technique[3] combined with multiaxial and multicomponent evaporation, to fabricate ensembles of 3D complex nanosystems over cm^2 areas. This has allowed us to obtain in the last years a diversity of magneto-plasmonic architectures with increasing degree of structural complexity and simultaneous in-plane (out-of plane) nanometer (subnanometer) control of the location and dimensions of the individual building blocks. This can be viewed as a nano-3D printer, with multiple cartridges corresponding to the different evaporation sources, the in-plane control being realized by the relative orientation of the hole mask template with respect to the evaporated material, and the out of plane control by the specific evaporation sequence. Examples will be shown on the fabrication of metal and metal-dielectric nanodisks, the corresponding morphologically complementary membranes, nanorods, nanorings and even more complex stacked ring-split / ring systems. They will also be illustrated with hints of their most relevant optical and magneto-plasmonic characteristics.

References

[1] G. Armelles et al., Advanced Optical Materials, 1 (2013) 10.
[2] H.Y. Feng et al, Nanoscale, 2017, DOI: 10.1039/C6NR07864H
[3] H. Fredriksson et al., Advanced Materials, 19 (2007) 4297.

Figures

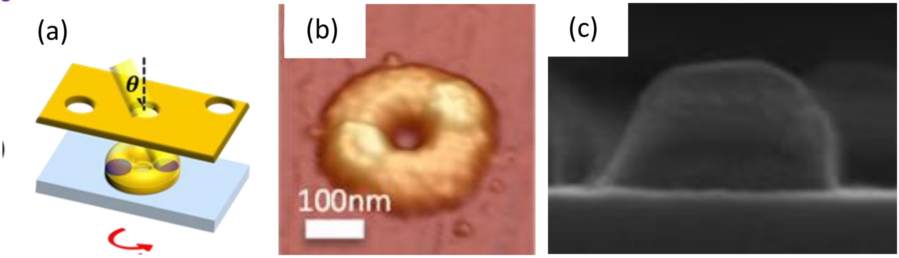

Figure 1: (a) Sketch of Au nanoring fabrication with Co inclusions (b) Corresponding AFM image in an intermediate fabrication step (H.Y.Feng, PhD Thesis) (c) SEM image of a metal/dielectric/metal magnetoplasmonic nanodisc.