High-throughput Fabrication of Engineered Plasmonic Nanoantenna Arrays with Nanostencil Lithography

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In this talk, we will demonstrate a novel fabrication approach for high-throughput fabrication of engineered infrared plasmonic nanorod antenna arrays with nanostencil lithography (NSL) [1]. NSL technique, relying on deposition of materials through a shadow mask, offers the flexibility and the resolution to radiatively engineer nanoantenna arrays for excitation of collective plasmonic resonances.

As stencil, we use suspended silicon nitride membrane patterned with nanoapertures and fabricate nanorod antenna arrays. Our spectral measurements and electron microscopy images faithfully confirm the feasibility of NSL technique for large area patterning of nanorod antenna arrays with optical qualities achievable by electron-beam lithography. Furthermore, we show nanostencils can be reused multiple times to fabricate repeatedly and reliability selfsame structures with identical optical responses. This capability is particularly useful when high-throughput replication of the optimized nanoparticle arrays is desired. In addition to its high-throughput capability, NSL permits fabrication of plasmonic devices on surfaces that are difficult to work with electron/ion beam techniques. Nanostencil lithography is a resist free process thus allows the transfer of the nanopatterns to any planar substrate whether it is conductive, insulating or magnetic. As proof of the versatility of the NSL technique, by simply changing the aperture pattern on the silicon nitride membrane, we show fabrication of plasmonic structures in variety of geometries and on different substrates.

Nanostencil Lithography enables plasmonic substrates supporting spectrally narrow far-field resonances with enhanced near-field intensities. Overlapping these collective plasmonic resonances with molecular specific absorption bands can enable ultrasensitive vibrational spectroscopy. We will also present our recent results on spectroscopic identification of proteins with antenna arrays fabricated by nanostencil lithography and optimization of the lithography process.

[1] S. Aksu, A. Yanik, R. Adato, A. Artar, M. Huang, H. Altug, "High-throughput Nanofabrication of Plasmonic Infrared NanoAntenna Arrays for Vibrational Nanospectroscopy", Nano Letters, 2010, 10 (7), pp 2511-2518.