Interest in metallic nanostructures has grown rapidly due to their unique optical properties like plasmonic field enhancement, paving the way for different surface enhanced spectroscopies as well as for novel metamaterials. New efficient wet-chemistry based fabrication methods have increased the interest even more. However, for metamaterials more complex shapes are needed than achievable by these methods. On the other hand, the conventional lithography based fabrication methods are able to produce arbitrary shapes, but nanostructures with metamaterial activity in the visible range are hard to fabricate, due to size limitations of these methods. Yet, DNA self-assembly provides a precise and programmable way to form nanoscale structures. Nevertheless, despite many attempts to metallize DNA structures, fabrication of metallic nanostructure accurately enough via DNA self-assembly is still challenging.

Here, we propose a novel method, which combines the DNA origami and conventional nanofabrication processes for production of high quality sub-100-nanometer plasmonic nanostructures with designed shapes. The method employs DNA origami silhouettes in a silicon dioxide layer, formed by DNA selective chemical vapor deposition process. Metal is subsequently evaporated onto the substrate through the formed mask yielding nanostructures with the shape of the origami. The resulting nanostructures have a feature size smaller than 20 nm which is already comparable to the e-beam lithography, but in a highly parallel and high-throughput fashion. Combined with large area DNA origami deposition, one can expand the fabrication to even larger scale in a very cost-effective way, providing thus great potential in fabrication of planar plasmonic nanostructures for plethora of applications, e.g., sensing and metamaterial.

To demonstrate the advantage of the method, we have successfully designed and fabricated variety of sub-100-nanometer gold nanostructures, e.g., bowtie antennas yielding significant SERS activity. Yet, nanoparticles with a double-L shape and selective orientation on a substrate raise clear planar chirality detected by circular dichroism spectroscopy.

Keywords: DNA origami, Plasmonic, Metamaterial

References:

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