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Surface plasmon waveguides nanofabricated using scaffold DNA origami

Wan Kuang, William Klein, Charles N. Schmidt, Blake Rapp, Sadao Takabayashi, Bernard Yurke, William B. Knowlton, Elton Graugnard, Jeunghoon Lee and William L. Hughes
Boise State University, USA

Noble-metal waveguides utilizing surface plasmon interactions are capable of serving as the building blocks of nanoscale photonic circuitry. Nanoparticles can also be arranged into arrays that function as a beam splitters, phase shifters, or crossover splitters on the sub-diffraction scale. Here, we demonstrate the use of DNA origami to arrange gold nanoparticles into arrays and create functioning, mechanically stable waveguides. DNA origami is a self-assembly technique, where hundreds of short (30-50 bases) synthetic oligonucleotides, so-called staple strands, are annealed with a long (8 kb) virus-derived scaffold strand. Such DNA origami structures can serve as precisely addressable templates onto which nanomaterials such as noble metal nanoparticles and quantum dots can be assembled. A specific location or "pixel," consisting of a staple strand, on the folded origami can be addressed because each pixel contains a unique DNA sequence. This spatial addressability provides great latitude of design for optical nanostructures.

Plasmonic waveguides consisting of linear gold nanoparticle (AuNP) arrays were synthesized by attaching 10 nm diameter AuNPs to a pair of dimerized DNA origami nanotubes. The properties of the plasmonic waveguides were characterized by combining atomic force microscopy (AFM) and optical far-field images. The independently collected AFM and darkfield images were registered and digitally overlaid, allowing the optical properties of individual waveguides to be correlated with their nanoscale structure. The scattering spectra were collected from the individual waveguide and it was found that the peak shifts between the longitudinal and transverse modes agree with the Fano model of nanoparticle scattering.

Biography

Wan Kuang completed his Ph.D. from University of Southern California. He is currently with the Department of Electrical and Computer Engineering at Boise State University.

wankuang@boisestate.edu