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A Variable Single Photon Plasmonic Beamsplitter

Niels Israelsen Kristiansen*, Shailesh Kumar, Alexander Huck, Jonas Schou Neergaard-Nielsen, and Ulrik Lund Andersen

Technical University of Denmark, Department of Physics, 2800 Kongens Lyngby, Denmark
*nikr@fysik.dtu.dk

Abstract

Plasmonic structures can both be exploited for scaling down optical components beyond the diffraction limit and enhancing and collecting the emission from a single dipole emitter. Here, we experimentally demonstrate adiabatic coupling between two silver nanowires using a nitrogen vacancy center as a probe source.

By making use of surface plasmon modes propagating along metallic nano-structures, it is possible to scale down optical components far beyond the standard diffraction limit of light. Among many other demonstrations, this has led to the construction of a plasmon based coupler operating in the 1550 nm wavelength range using directional coupling between two metallic nanowires [1]. Furthermore, due to the strong field confinement of plasmonic modes the spontaneous emission from a single photon source can be greatly enhanced and channelled into a well-defined spatial mode, which is a promising tool for building a bright on-demand single photon source [2].

We experimentally demonstrate and test with single photons the construction of a plasmonic beam-splitter based on evanescent adiabatic coupling between two surface plasmon polariton (SPP) modes propagating along individual silver nanowires with diameters of 88 nm. Using a scanning probe technique [2, 3], we first couple a single nitrogen vacancy center located in a nano-diamond to the SPP mode propagating along a silver nanowire. After this, we partially couple the excited SPP to a second nanowire by positioning it close to the first nanowire with a minimum gap of about 50 nm, as shown in Fig. 1. With this configuration we obtain efficient coupling to the SPP mode of the second wire, which is otherwise not excited, and finally back to the first wire by further reducing the gap size. All experimental results are well supported by numerical finite element simulations.

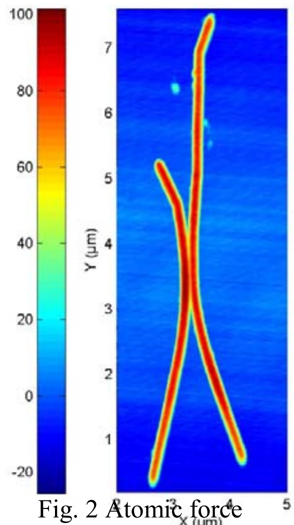

Fig. 2 Atomic force microscope height profile of the beamsplitter system in [nm].

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