

Technical University of Denmark



A Variable Single Photon Plasmonic Beamsplitter

Israelsen, Niels Møller; Kumar, Shailesh; Huck, Alexander; Neergaard-Nielsen, Jonas Schou; Andersen, Ulrik Lund

Publication date:
2013

Document Version
Publisher's PDF, also known as Version of record

[Link back to DTU Orbit](#)

Citation (APA):
Israelsen, N. M., Kumar, S., Huck, A., Neergaard-Nielsen, J. S., & Andersen, U. L. (2013). A Variable Single Photon Plasmonic Beamsplitter. Paper presented at Quantum Information Processing and Communication 2013, Florence, Italy.

DTU Library

Technical Information Center of Denmark

General rights

Copyright and moral rights for the publications made accessible in the public portal are retained by the authors and/or other copyright owners and it is a condition of accessing publications that users recognise and abide by the legal requirements associated with these rights.

- Users may download and print one copy of any publication from the public portal for the purpose of private study or research.
- You may not further distribute the material or use it for any profit-making activity or commercial gain
- You may freely distribute the URL identifying the publication in the public portal

If you believe that this document breaches copyright please contact us providing details, and we will remove access to the work immediately and investigate your claim.

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.

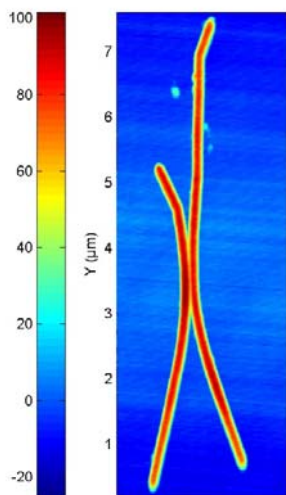


Fig. 2 Atomic force microscope height profile of the beamsplitter system in [nm].

References

- [1] Qiang Li, Shanshan Wang, Yiting Chen, Min Yan, Limin Tong and Min Qiu, “Experimental Demonstration of Plasmon Propagation, Coupling, and Splitting in Silver Nanowire at 1550-nm Wavelength”, *IEEE Journal of Selected Topics in Quantum Electrodynamics* 7, 4 (2011).
- [2] Alexander Huck, Shailesh Kumar, Abdul Shakoor, and Ulrik L. Andersen, “Controlled Coupling of a Single Nitrogen-Vacancy Center to a Silver Nanowire”, *Phys. Rev. Lett.* 106, 096801 (2011).
- [3] Shailesh Kumar, Alexander Huck, and Ulrik L. Andersen, “Efficient Coupling of a Single Diamond Color Center to Propagating Plasmonic Gap Modes”, *Nano Lett.* 13 (3), 1221 (2013).