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Improved Coupling To Plasmonic Slot Waveguide Via A Resonant Nanoantenna

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Plasmonic waveguides are considered as a future generation of optical interconnects in integrated circuits for datacom technologies due to their extreme field confinement performance. Inevitably, when using nanoscale waveguides, a new challenge emerges: how to effectively couple the diffraction-limited optical waves into deep-subwavelength plasmonic waveguides.

In this contribution we provide a systematic approach to design, fabricate and characterize an efficient, broadband, and compact dipole antenna nanocoupler for the telecom wavelength range around 1.55 μm. We consider the vertical coupling configuration with a realistic excitation directly from an optical fiber. The scattering-type scanning near-field optical microscope (s-SNOM) characterization allows us not only to make relative comparison of the efficiencies (in terms of the effective area) of different couplers, but also to measure the effective index and propagation length of the slot waveguide mode. All experimental data are in very good correspondence with the numerical simulations. It was also confirmed that the serially connected dipole antennas represent the most efficient and simple design of nanocouplers. We report 26- and 15-fold improvements in the coupling efficiency with two serially connected dipole and modified bow-tie antennas, respectively, as compared to that of the short-circuited waveguide termination. We also emphasize that the s-SNOM-based characterization procedure will become a standard robust technique for the plasmonic waveguide characterization due to its high resolution and reliable measurements.