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Advances in silicon nanophotonics

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Silicon has long been established as an ideal material for passive integrated optical circuitry due to its high refractive index, with corresponding strong optical confinement ability, and its low-cost CMOS-compatible manufacturability. However, the inversion symmetry of the silicon crystal lattice has been an obstacle for a simple realization of electro-optic modulators, and its indirect band gap has prevented the realization of efficient silicon light emitting diodes and lasers. Still, significant progress has been made in the past few years.[1] Electro-optic modulators based on the free carrier plasma effect have been tested up to 40 Gbit/s,[2] and hybrid evanescent silicon lasers have been realized both in the form of distributed feed-back lasers[3] and micro-disk lasers.[4] For enhancing the impact of silicon photonics in future ultrafast and energy-efficient all-optical signal processing, e.g. in high-bit-rate optical communication circuits and networks, it is vital that the nonlinear optical effects of silicon are being strongly enhanced.[5] This can among others be achieved in photonic-crystal slow-light waveguides[6] and in nano-engineered photonic-wires[7] (Fig. 1). In this talk I shall present some recent advances in this direction. The efficient coupling of light between optical fibers and the planar silicon devices and circuits is of crucial importance. Both end-coupling[8] (Fig. 1) and grating-coupling[9] solutions will be discussed along with polarization issues[10]. A new scheme for a hybrid III-V/silicon laser will also be discussed briefly.[11]

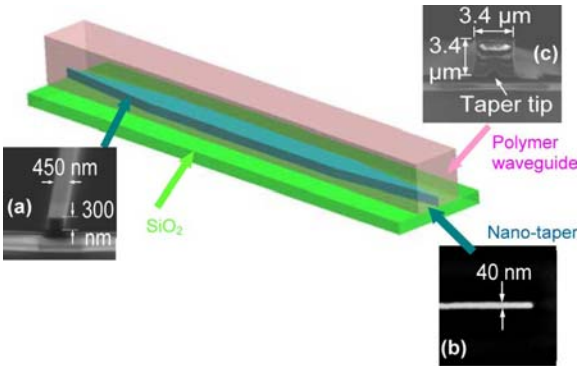

Fig.1. Schematic drawing of a nano-engineered silicon waveguide with SEM pictures of (a) cross section of the silicon waveguide, (b) top view of the silicon nano-taper tip, and (c) cross-section view of the nano-taper coupler with cladding polymer waveguide.

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