NANO HIGHLIGHT
Nanophotonics for optical delay engineering

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Integration of nanophotonic devices is important for reducing the weight, power, and cost of various information systems including those intended for large-scale computing, telecommunication and sensor networks, biomedical instrumentation, and national security applications. Nanophotonic devices utilize the unique properties of inhomogeneous material systems. High refractive index materials (Silicon) provide strong light confinement, resulting miniaturization, enhancement of optical nonlinear interactions, and control of near fields within these novel devices. When such material arrangements are set to resonance, they are called Photonic Crystals (PhC) and serve as a unifying integration platform for future nanophotonic systems. This technology may enable the realization of new devices with the properties of optical transistors and logic gates, thereby ultimately allow construction of highly integrated information systems.

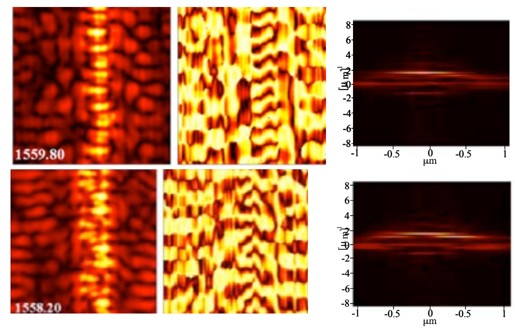

Fig. 1: Amplitude (left), phase (center) and 1-D Fourier transform (right) of the optical field propagating through the W1 PhC waveguide. Top raw was measured at λ=1559.8 nm and bottom at λ=1558.2 nm.

Typical dimensions of nanophotonic materials and devices vary in a size range between ten to hundred of nanometers. Correspondingly, such small features are usually impossible to resolve with conventional microscopy where resolution is limited by the wavelength of light. Proper device characterization is therefore challenging. To combat the shortcomings of conventional optical microscopy, we employ a near field microscope, which offers image resolution determined by the size of its nanoscopic probe. This probe collects weak, evanescent, near-fields from a functioning device that are not detectable with a standard microscope. Subsequent heterodyne detection allows us to measure both amplitude and phase of these fields while also providing an amplification to boost the weak signal. Measuring processes that occur in the near field of the nanodevices opens opportunity to better understand near field interactions between discrete nanodevices and to engineer future systems with superior performance in terms of size, weight, power consumption, and reliability. Recently we used our instrument to measure amplitude and phase of optical modes propagating in a PhC lattice with one missing row (a "W1 PhC" waveguide). Fig. 1 shows experimental results for mode propagation in the W1 PhC fabricated in a silicon membrane with lattice period of 496 nm, air holes of radius 190 nm, and a membrane thickness of 290 nm. Knowledge of the amplitude and phase makes possible the employment of spectrum analysis techniques to experimentally find the propagation constants of the excited modes as shown in Fig. 1 (right). We are currently exploring the use of our near field characterization tool for studies of surface plasmon polariton (SPP) modes [2] as well as the near field electrodynamics of femtosecond SPP fields [3].

References

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[3] R. Rokitski, K. Tetz and Y. Fainman Phys. Rev. Lett. 95, 177401 (2005).