NEAR FIELD IMAGING OF LIGHT CONFINEMENT AND PROPAGATION IN SOI BASED PHOTONIC CRYSTAL DEVICES

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As processors density increases, intra- and inter-chip electrical connections are going to face limitations in term of miniaturization, dissipated energy and bandwidth. Optics could be an alternative if we realize light emitters, guides and receptors using CMOS compatible technologies by taking advantage of photonic crystal (PC) structures and Silicon-On-Insulator (SOI) substrate.

Due to the high refractive index contrast between silicon and silica, SOI substrates provide a naturally good template for the introduction of optics at the microelectronic devices level. If one is able to control the propagation of photons in the material, functional devices like filters, modulators or resonant detectors can be envisaged. A promising way to integrate these functions in compact large-scale photonic circuits is to use photonics crystals (PCs) because of their ability to mold the flow of light[1]. Nevertheless, due to their size of the order of a few hundred nanometer for near-infrared applications, the experimental way of characterization of photonic crystal based devices, like transmittance or photoluminescence measurements, lead to macroscopic information on their optical properties.

Recent works have demonstrated the potential of near-field methods to collect information about the distribution of the electromagnetic field inside integrated devices[2]. In this work, we have combined at the same time both near- and far-field techniques to perform spectrally resolved near optical field imaging of photonic band gap structures like waveguides and integrated resonant cavities.

PC structures are realized by using silicon microelectronic technologies[3] (electron beam/UV lithography, dry etching…) and we have performed transmittance measurements on a broad spectral range to determine the spectral properties of the devices[4]. Then near-field analysis by using a scanning near-field optical microscope (SNOM) in collection mode allows us to map the distribution of the electromagnetic field inside the devices as a function of the wavelength.

We evidence in a first time the different field distribution corresponding to the classical properties of the photonic crystal based devices such as light confinement along photonic crystal waveguides and inside cavities, interferences pattern due to reflection of light in the photonic band gap and we localize the origin of losses inside those components. In a second time, we demonstrate that near-field imaging technique also permits to evidence unexpected phenomenon inside the components such as Bloch mode parity change inside photonic crystal waveguide[5]. At last all the experimental pictures are discussed in light of field distribution obtained by Finite Difference Time Domain and Plane Wave Expansion methods and a good agreement is generally found.

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