6351-99, Session 10a

[Invited] Silicon nanophotonics using deep-UV lithography

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We will present recent progress in several devices based on silicon-on-isulator nanophotonics using deep-UV lithography. We will report on high efficiency couplers, ultra-compact arrayed waveguide gratings and ring-resonator based biosensors.

6351-100, Session 10a

Theoretical and experimental study on polymer microstructured fibers

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Microstructured optical fibres(MOF) have attracted increasing interest since they were first developed in 1996, which is mostly due to the fact that the wide optical characteristics can be obtained by designing an appropriate hole pattern for the final fibre. Recently, polymer microstructured fibres (PMOF) have been designed and fabricated, and polymethylmethacrylate(PMMA) is commonly used as resource material. However, because of a shorter history than that of silica MOFs, PMOF isn't extensively researched and its excellent characteristics can't be obtained.

The index guide fiber is simulated with a full vector Frequency Domain Finite Difference (FDFD) with Perfect Matched Layer (PML) absorbing boundary condition. An index average technique is used to improve the refractive index resolution of the algorithm. The mode transmission constant and mode field distribution can be obtained by using FDFD algorithm. Through the imaginary part of the complex mode transmission constant, leakage loss can be calculated. However, for a band gap type PMOF, it is difficult to find the base mode and band gap by the method. Using the PWE method, we could find the bandgap structures of photonic crystals. The electromagnetic and the dielectric constant were expanded based on plane wave in the reciprocal lattice space, and then substituted into Maxwell's equations. Maxwell's equations are solved and then the dispersion curves that are also the bandgap structure can be received.

A index guide type PMOF with liquid crystal core is designed.The distance between two air holes(L), the diameter of liquid crystal core(d2) and the diameter of cladding holes are 20um, 14um and 8um respectively. Using the structure, we want to design a liquid crystal tunable attenuator. So a large extinction ratio is required for different liquid crystal index of the core. In this work, the 5CB thermo-sensitive liquid crystal material is used ,the refractive index of which is from 1.5 to 1.7 as the temperature changes from 20 °C to 45 °C. When the index of core is 1.5, the mode field expands seriously and the leakage loss is very large. However, When the index of core is 1.7,the mode field is confined very well ,which can be used as a open state.

For the case of band gap type PMOF, the distance between two air holes(L) is 3um, and the diameter of air hole(d) is 2.7um so that d/L is 0.9. Seven holes is removed to make a guide light defect. Band gap distribution can be calculated by using PWE method. In the gap region of air line passing, the light of certain frequency can be guided.

PMOF was fabricated by drawing the perform of stacked polymer capillary tubes. A PMMA hollow rod is obtained from squeezing technology. PMMA capillary tubes were fabricated by the thermal drawing of the PMMA tube at 170 °C -180 °C with a proper speed. We have designed and constructed a drawing tower for fabrication of the capillaries and PMOF. The diameter of the capillary tubes was controlled by the feedback between the capstan speed and diameter measured from a gauge. The drawing furnace was designed to have a proper temperature profile along the feeding direction. The fabricated capillaries have a diameter of 0.4 mm and are arrayed to make a perform for the PMOF by hexagonal stacking. The arrayed capillaries are inserted into a large diameter PMMA tube jacket and drawn again to get a PMOF at 180 °C.

The microscopic images of the end surface of the fabricated liquid crystal core and hollow core PMOF. Some measurement results have been obtained. For the case of the former, the extinct ratio get to 50dB as temperature change from 23 °C to 38 °C. For the case of the latter, some results will be obtained.

6351-101, Session 10a

Conical and bi-conical ultra-high-Q optical-fibre-nanowire microcoil resonator

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Recently, a new 3D high-Q resonator (the self-coupling optical-nanowire microcoil-resonator (ONMR)) has been proposed which, thanks to the huge improvement in the fabrication of low loss nanowires, could potentially compete with the highest quality factor Q achieved in whispering gallery resonators. In this paper, new profiles of ONMRs are suggested and investigated theoretically.

Because the Q-factor is inversely proportional to the full-width-at-half-maximum (FWHM) of the peak observed in the transmission spectrum, we solve the coupled wave equations and investigate the dependence of FWHM on the coupling parameter K in three different profiles of ONMRs (cylindrical, conical and biconical). FWHM has an aperiodical dependence on K, which in turn is very sensitive to the distance between two adjacent turns. In order to compare the easiness of obtaining high Q-factor resonators we consider the tolerance range which we define as the percentage of K where the FWHM is close to its minimum value. Higher tolerance ranges mean easier fabrication of low-FWHM/high-Q ONMRs. Our numerical investigations show that (a) the tolerance range of both the cylindrical and biconical profiles rapidly increases with the number of turns; (b) the biconical profile is the best and its tolerance range is near 150% of that of the cylindrical contour; the conical profile, on the other hand, is by far the worst geometry with a tolerance range close to zero. The first inference (a) means that a high Q-factor can be achieved by coiling as many turns as possible. However, in practice the fabrication of devices with more turns is much more difficult. Inference (b) suggests that high Q-resonators can be more easily fabricated by controlling the geometry.

In conclusion, our simulations demonstrated that the biconical profile provides a considerable advantage over conical and cylindrical profiles when fabricating high-Q ONMRs.

6351-102, Session 10a

The coupling of defects in 1D left-handed photonic crystal

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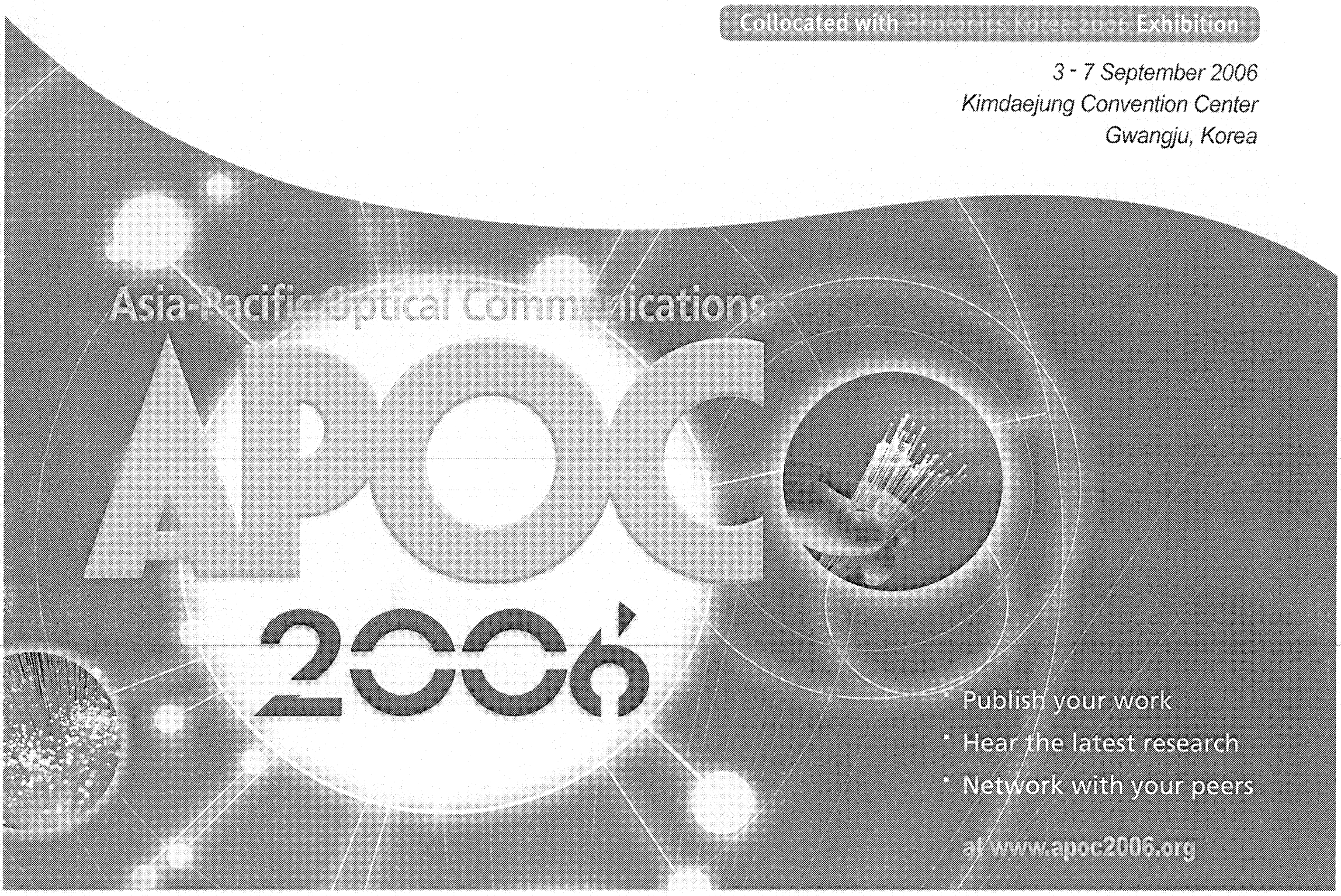
Photonic crystal is an artificially optical material with periodically modulated dielectric, which leads to generation of photonic band gaps. Recently, a new type of artificially fabricated electromagnetic material with both negative dielectric permittivity and negative magnetic permeability called left-handed materials (LHM) brings more space for photonic crystal_s development. Recently, one-dimensional (1D) LHM PC consisting of alternating slabs of two materials with positive and negative refractive index attracted intensive studies. It is demonstrated that a left-handed photonic crystal with zero averaged refractive index displays a new type of narrow spectral gap called zero averaged refractive index (ZARI) gap in the transmission, which is quite different from traditional Bragg gap. The ZARI gap only display when the average refractive index is equal to zero, and it is independent of scaling and insensitive to the disorder and the incident angle of incident wave. Such features should bring about many novel applications, such as beam shaping and omnidirectional reflector. Furthermore, left-handed www.apoc2006.org



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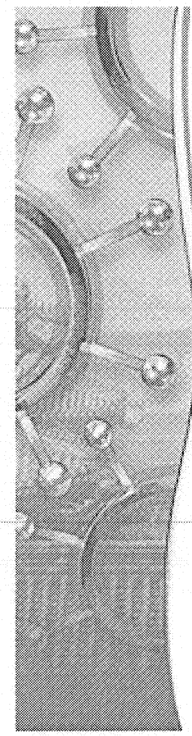

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