Mode-coupling in photonic crystal fibers with multiple cores

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Fabrication of photonic crystal structure in fluorine-doped silicon dioxide film by dry and wet etching processes

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Photonic crystals have been studied extensively because of their strong possibility in light control. Several techniques to form such structures have been reported so far. In this paper, we propose novel method for fabrication of two-dimensional (sub-three-dimensional) periodic structures. We demonstrate the fabrication of a prototype structure, i.e., two-dimensional array of mushroom structures.

Figure 1 shows the fabrication process. Pure SiO₂/F-doped SiO₂ two-layer thin film was formed on Si substrate by plasma enhanced chemical vapor deposition (PECVD) using tetraethoxysilane (TEOS) and CF₄. The concentration of fluorine was estimated as about 20% in volume ratio. Then two-dimensional periodic structure was formed by photolithography and dry etching with CF₄. Finally, the mushroom structures were formed by the selective wet etching with 5%HF solution. Figure 2 shows the fabricated structure. The period was 4.0μm, and the thickness of the two layers was about 5 μm each. A mushroom structure was easily formed because the etching rate of the F-doped SiO₂ film was six times as high as that of undoped film. We are continuing experimental work to form the structure with shorter period to examine the optical properties of each component. The shape of each component was controlled precisely depending on the concentration of fluorine. The structure stacking with mushroom shape or other shapes will be demonstrated in the presentation.

Fig. 1 Flow diagram of fabrication process

Fig. 2 SEM view of fabricated structure

Mode-Coupling in Photonic Crystal Fibers with Multiple Cores

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We have fabricated photonic crystal fiber (PCF) [1] with multiple cores by drawing a fiber preform from mixed glass tube [2]. Fig. 1 is a cross-section of the fiber showing the three cores. One core is near the center, another is to the left, and the third is at the top right, well separated from the first two.

Fig. 1 Cross section of PCF with three cores. Note that the cores are in close proximity to each other

Fig. 2 Transmission through PCF fiber containing two cores. The confinement of light in the second core is clearly visible.

Fig. 3 SEM view of fabricated structure

Mode coupling between the three cores was clearly demonstrated. The results are shown in Fig. 4. At 1310 nm we observe significant coupling, indicating resonant coupling efficiency for a fiber with high losses. At 1550 nm the coupling is both lower and wider, indicating the wavelength shift of the resonant mode. In the near-field images, the field is imaged with a large objective lens. The observed mode coupling is localized near the center of the core.