FEM Lab

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SK2402 Fundamentals of Photonics

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1 Task I: Solid-core photonic crystal fiber

1.0.1 Subtask A

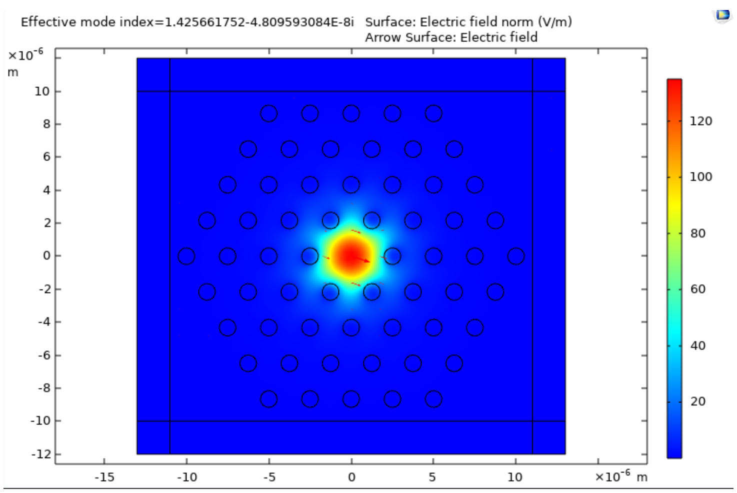


Figure 1: Electric field of the fundamental mode inside a photonic crystal fibre

The effective mode index of the fundamental mode in photonic crystal fibre is 1.42 - $i4.80 \times 10^{-8}$.

1.0.2 Subtask B

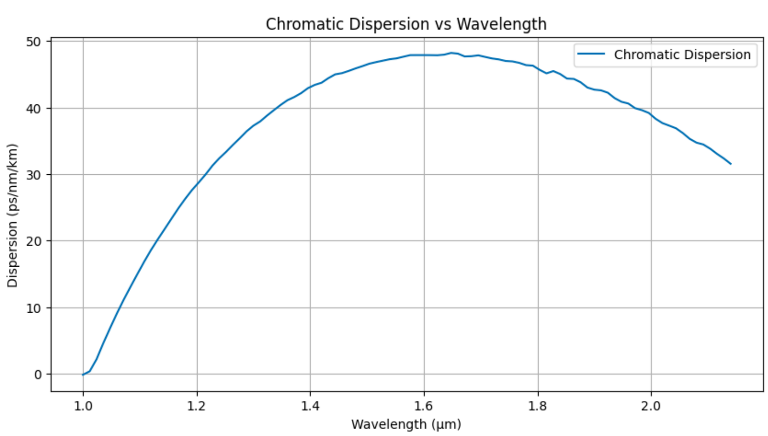


Figure 2: Chromatic Dispersion vs Wavelength

Conventional optical fibres, such as silica-based single-mode fibres, exhibit a natural dispersion that increases with wavelength.

The dispersion of a PCF depends on the wavelength of the light and the size and arrangement of the air holes. The dispersion of a PCF (shown in the above figure) is lower than that of a traditional single-mode fibre. This is because the air holes in the cladding can act as a waveguide for light, which can help to cancel out some of the dispersion.

2 Task II: Hollow-core photonic bandgap fibre

2.0.1 Subtask A

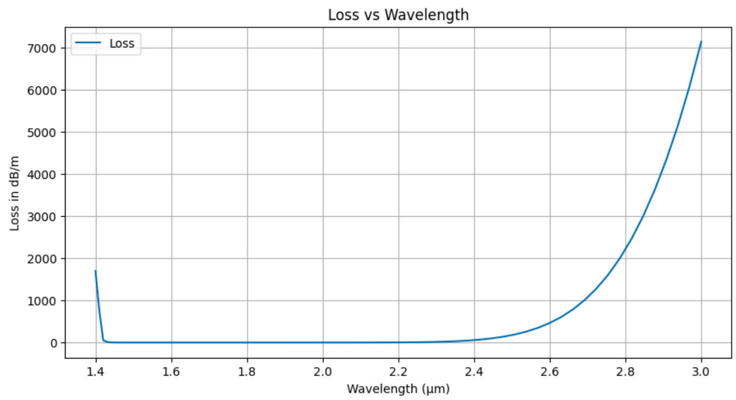


Figure 3: Loss vs Wavelength

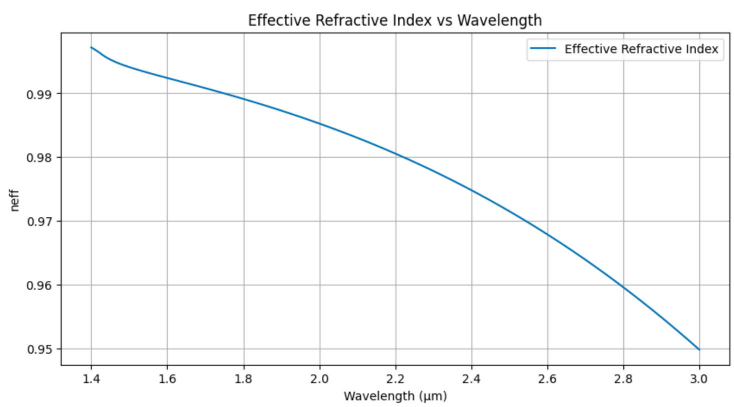
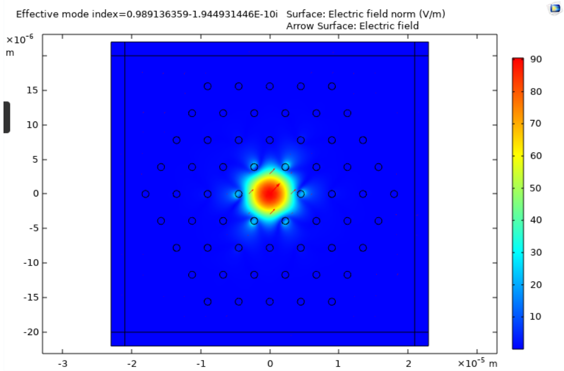
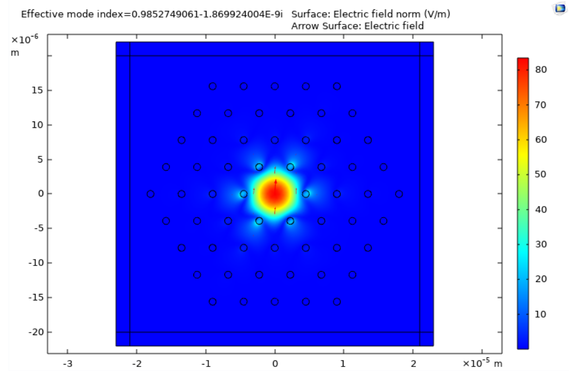


Figure 4: Effective Refractive Index vs Wavelength

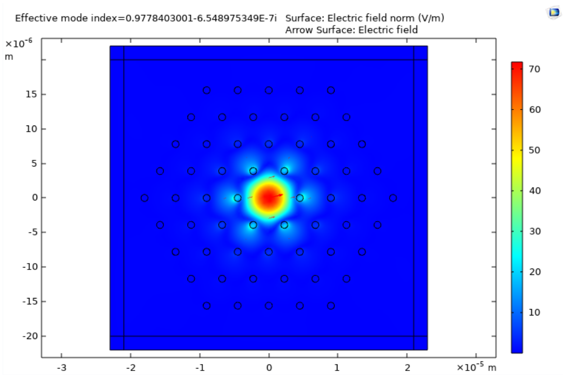
2.0.2 Subtask B



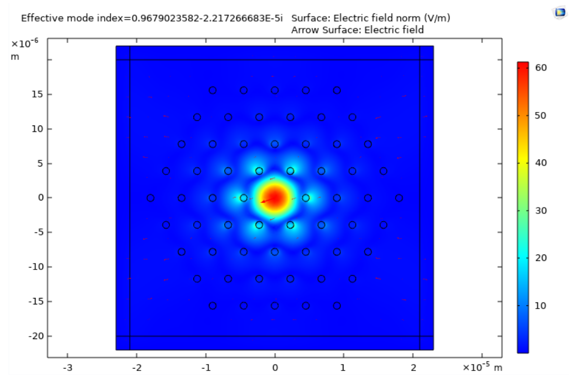
(a) Input Wavelength 1.8 μm



(b) Input Wavelength 2 μm



(a) Input Wavelength 2.3 μm



(b) Input Wavelength 2.6 μm

Due to the bandgap properties of a Hollow core photonic fibre, the electric field distribution changes with wavelength. As shown in the above figures, the maximum value of the electric field at 1.8 μm is 80 V/m, whereas it goes to 60 V/m for 2.6 μm. The photonic bandgap is stronger for shorter wavelengths, causing the light to be more tightly confined within the core. This results in a smaller electric field distribution at shorter wavelengths. As the wavelength increases, the photonic bandgap weakens, allowing the light to spread further into the cladding. Consequently, the electric field distribution increases with increasing wavelength.