Introduction to photonics

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Dispersion optimization of photonic crystal fibers using comsol simulator

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Phase 2.

Aim:

Validate dispersion curve for the structure of the photonic crystal fiber.

Validation of dispersion curve:

The chromatic dispersion of the PCF can be calculated from equation (1).

$$D = -\frac{\lambda}{c}\frac{d^2[\mathrm{Re}(n_{eff})]}{d\lambda^2} \qquad (1)$$

as it depends on wavelength, speed of light, $\mathrm{Re}(n_{eff})$ the real part of complex refractive index, se we can calculate dispersion by changing values of wavelength and its relation with $\mathrm{Re}(n_{eff})$.

First:

Let lambda=1.30[um] we will get these effective refractive index values as one represents x-polarization and the other represents y-polarization.

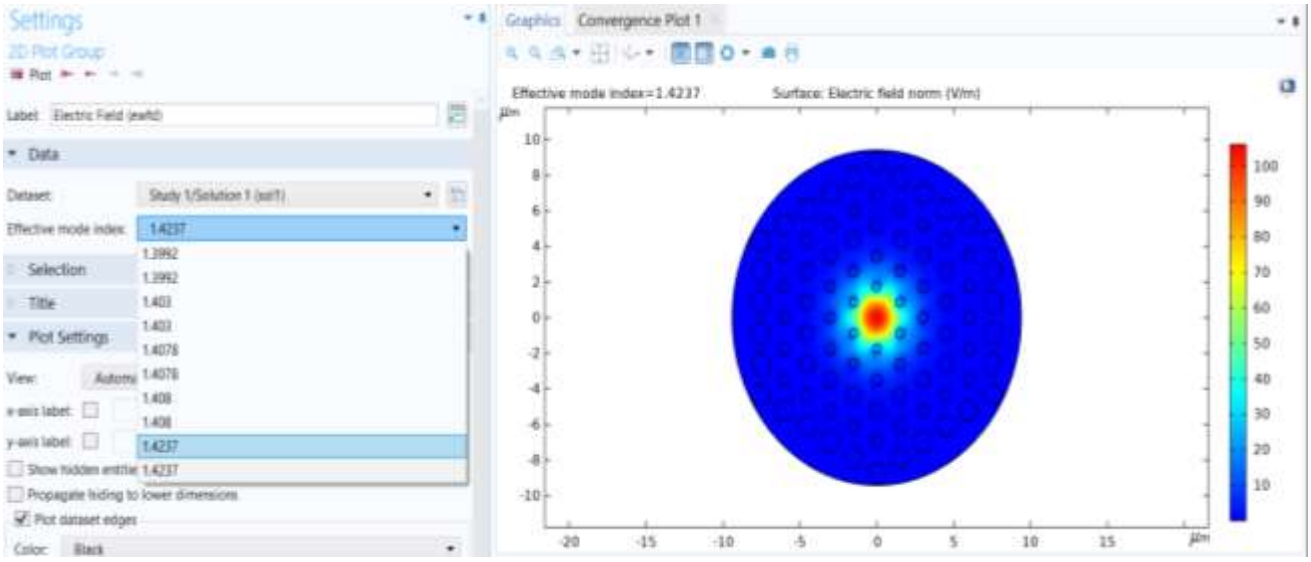

Fig (1). Plot at wavelength 1.30[um]

The x-polarization plot can be seen clearly form arrow surface applied on the structure as:

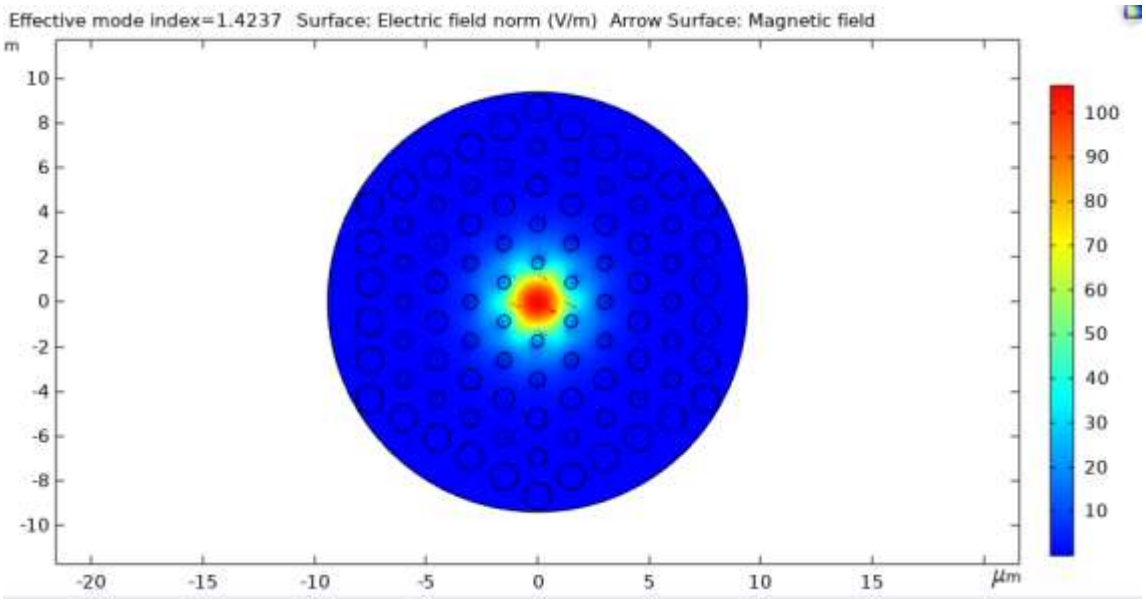

Fig (2). X-polarization at wavelength 1.30[um]

The y-polarization plot can be seen clearly form arrow surface applied on the structure as:

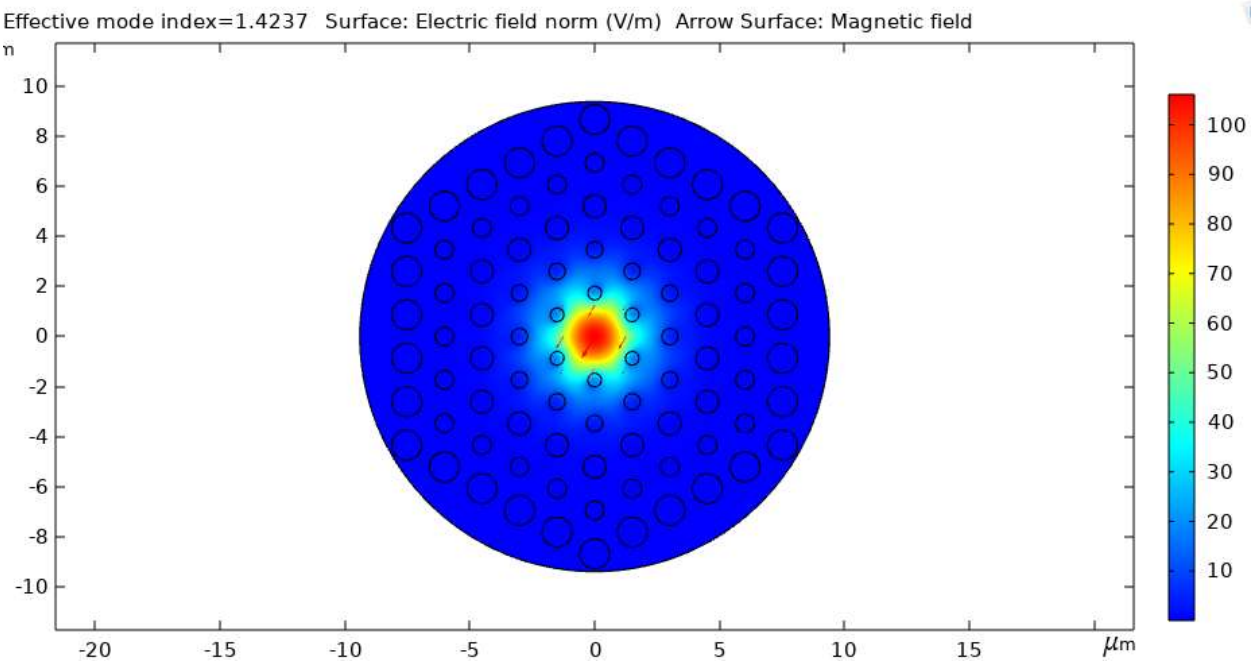

Fig (3). Y-polarization at wavelength 1.30[um]

After that we get the real and imaginary effective refractive index as shown :

Effective mode index	real(ewfd.neff) (1)	imag(ewfd.neff) (1)
1.4237	1.4237	-1.4750E-12

Second:

Let lambda = 1.35[um].

We will do the same analysis to get n_effective values for every lambda by parametric sweep or doing every wavelength separtley , then get their effective mode index values .

Effective mode index	real(ewfd.neff) (1)	imag(ewfd.neff) (1)
1.4225	1.4225	-2.8829E-12

Let lambda = 1.45[um].

Effective mode index	real(ewfd.neff) (1)	imag(ewfd.neff) (1)
1.4202	1.4202	-1.0290E-11

Let lambda=1.5[um]

Effective mode index	real(ewfd.neff) (1)	imag(ewfd.neff) (1)
1.4191	1.4191	-1.8804E-11

Let lambda=1.55[um]

Effective mode index	real(ewfd.neff) (1)	imag(ewfd.neff) (1)
1.4191	1.4664	-1.9430E-11

Let lambda=1.6[um].

Effective mode index	real(ewfd.neff) (1)	imag(ewfd.neff) (1)
1.4168	1.4168	-5.8873E-11

Let lambda=1.25 [um].

Effective mode index	real(ewfd.neff) (1)	imag(ewfd.neff) (1)
1.4248	1.4248	-7.3793E-13

Let lambda=1.3[um]

Effective mode index	real(ewfd.neff) (1)	imag(ewfd.neff) (1)
1.4237	1.4237	-1.4752E-12

After collecting these data, we can use excel to calculate dispersion and represent the data od excel graph as shown in figure 4.

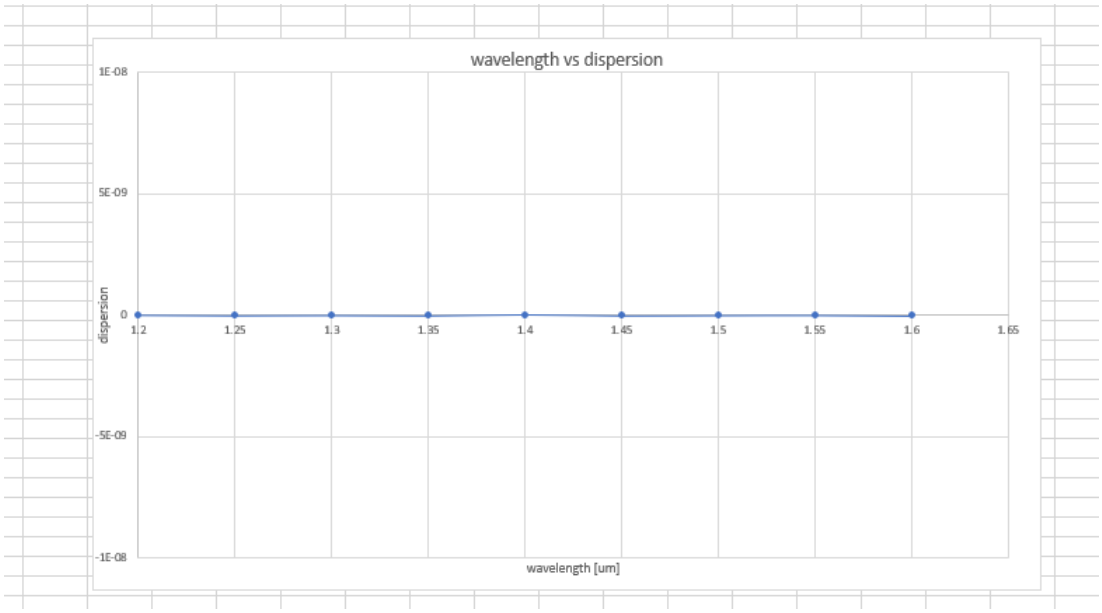

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Fig (4). Wavelength vs dispersion curve

Following Table shows the data collected:

wavelength[um]	neff	differentation	dispertion
1.15	1.4352		
1.2	1.4346	-3.68	1.472E-14
1.25	1.4248	3.48	-1.45E-14
1.3	1.4237	-0.04	1.73333E-16
1.35	1.4225	4.4	-1.98E-14
1.4	1.4323	-8.76	4.088E-14
1.45	1.4202	4.4	-2.12667E-14
1.5	1.4191	0.44	-2.2E-15
1.55	1.4191	-0.92	4.75333E-15
1.6	1.4168	5.92	-3.15733E-14
1.65	1.4293		

Table (1). data

Dispersion curve from the collected data nearly equals zero due to the small dispersion values, the curve's profile is not clearly noticed as the one in the study.