Modal Properties of Photonic Crystal Fibers

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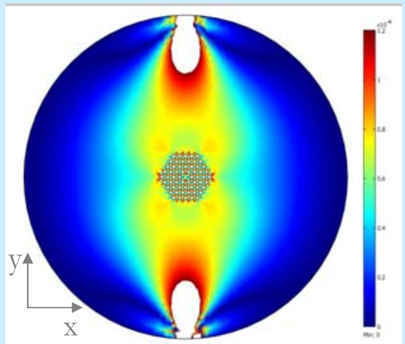
There has been extensive research on photonic crystal fibers (PCF) which have specially arranged air holes in the microstructure fiber core. Even though the stress effects in such fibers has been studied, it was limited to a few microstructure geometries. We would like to extend the study on a wider variety of new structures. Our goal is to establish the model using commercially available software, COMSOL Multiphysics, and verify these models with published work and extend the study to new microstructures.

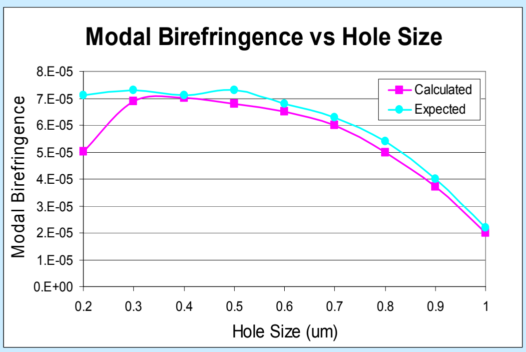
Physical Model

We duplicated a model made by Professors Zhu and Brown at the University of Rochester. A 62.5 µm radius silica fiber was created with four rings of air holes in a hexagonal array. A 1000 N force was applied laterally on the fiber. The force induced anisotropy in the material changing the effective refractive indices of the silica in the x- and y- axis. We calculated the material birefringence by taking the difference between the x- and y- refractive indices.



Birefringence Model

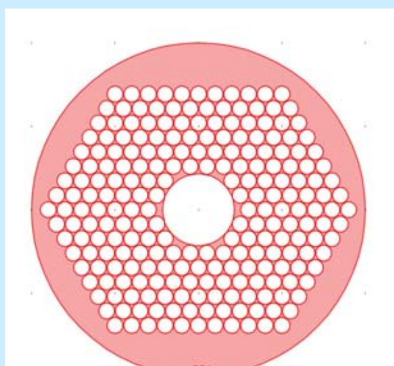
Results



The fiber we created relies upon a combination of total internal reflection and the photonic band gap to trap the light within its core. We varied the size of the air holes and calculated the birefringence of the trapped modes propagating axially in the fiber. In anisotropic structures light is able to propagate with many modes. We calculated the modal birefringence as the difference between the trapped light modes in the fiber core. Our findings matched the expectations within 10% on average.

Future Work

10 years ago a new discovery led to hollow core photonic band gap (PBG) fibers. These fibers appear similar to microstructured optical fibers; however they have an air or vacuum filled core, larger arrays, and require a smaller fraction of silica to air. The PBG fiber are capable of extremely low loss transmission without nonlinear optical effects - due to the air core. We plan to create a PBG model and investigate further into this new promising fiber.



Hollow Core PBG Fiber

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