Center for Optical Technologies

All-Optical Functionalities
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Towards glass-organic hybrid microstructured fibers

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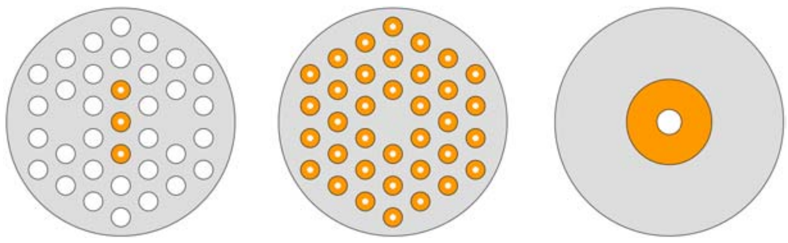
Enabling a separate control of optical nonlinearities and dispersion in optical fibers

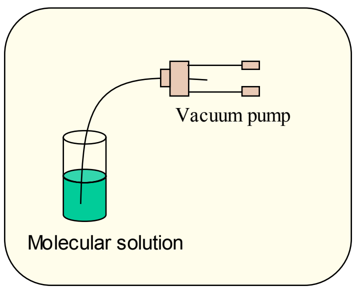
- Combine the dispersion and mode-size control of microstructured fibers with the highly tailorable optical and nonlinear optical properties of organic molecules.
- Use the high nonlinearity of small, robust molecules that can be sublimated without decomposition and allow vapor deposition of thin organic films
- Organic molecules with extended electron conjugation have large non-resonant third order susceptibilities and are attractive because of the possibility of fine-tuning their chemical structure and properties.

Microstructured optical fibers

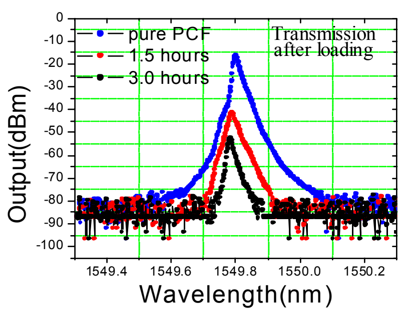


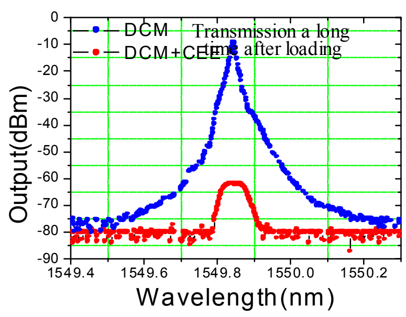
A few examples of what could be done by inserting a nonlinear optical materials into a microstructured fiber. From a fiber with two cores coupled by a nonlinearly modified section, to the creation of a photonic bandgap structure by the higher refractive index of the inserted material, to a simple case of a capillary-like fiber filled to form a long single-mode organic fiber.

Inserting Molecules in Solution

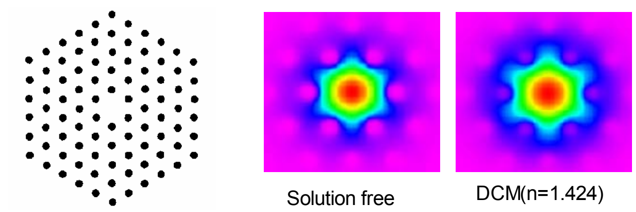


We have been able to demonstrate first hybrid structures by inserting a liquid solution containing the nonlinear molecules into the fibers. Optical transmission measurements have shown the presence of molecular aggregates that cause losses by guiding and scattering. In addition, the solution forms microcrystals inside the holes of the fibers as the solvent evaporates, which results in further transmission loss by scattering.

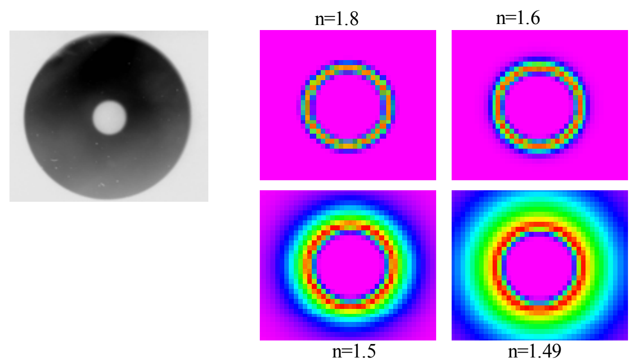




Numerical Calculations



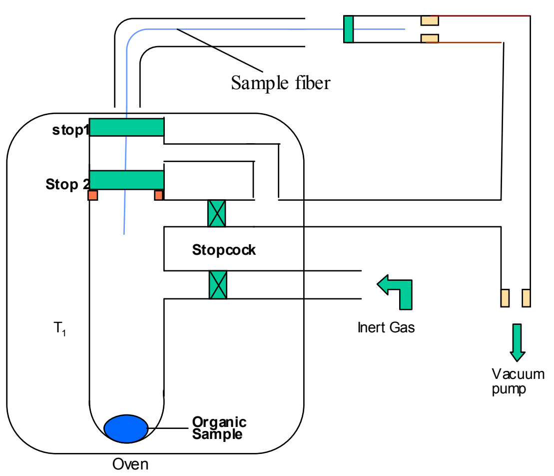
The presence of a solution influences mode profiles in microstructured fibers. The refractive index of the solution is lower lower than silica and the light is still guided, but the mode size expands, increasing the overlap between the optical field and the solution.



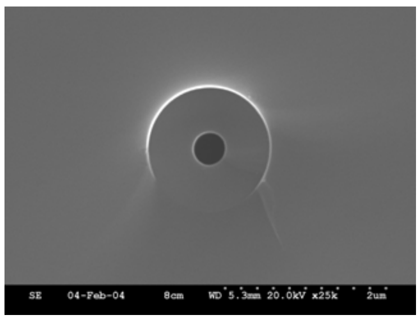
A solid state organic film, on the other hand, has a refractive index larger than glass, and modifies the optical mode differently. A simple example is the case of a single hollow tube where sublimated molecules are deposited with the thickness 1 μm

Inserting Molecules by Vapor Deposition

The nonlinear optical organic molecules we are focusing on in this project have the extraordinary property that they can be sumblimated without decomposition, which should allow us to bring them into the microstructured fiber in the vapor phase and let them condense there to form a homogenous, amorphous, filling.



Fiber Filling Technology



Badding, Sazio, and Gopalan et. al. (see separate poster) have filled microstructured optical fibers with materials, such as silicon, shown here, and Badding is adapting the techniques for use with molecules.