The prospective for the biodegradable microstructured optical fibers

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Advantages of Polymer Material Combination Over Glasses:

- Low cost materials
- Ease of handling and preform prototyping, several polymers can be used in the same fiber
- Polymers are generally more “bio-friendly” (biocompatible)
- Polymer fibers can be environmentally friendly (biodegradable)
- Active polymer structures can be introduced by bio-functionalizing polymer matrix with complex materials (therapeutics: anesthetics, anti-inflammatory drugs, etc.)
- Active materials (nanoparticles, low melting point metals, semiconductors, etc.) can be incorporated into preform to implement integrated sensor/power delivery fiber.
Advantages of Polymer Fiber Drawing over Glass Fiber Drawing

In a melted state surface tension of polymers is typically significantly smaller than surface tension of glasses, thus it is easier to avoid surface tension induced collapse of microstructure during drawing (no core pressurization, single zone furnace, etc.)

Composite polymer fibers incorporating two or more different polymer materials are relatively straightforward to fabricate by matching polymer thermo-mechanical properties via chemical manipulation of their structure and composition.

Bio-friendly ‘ColorFull’ plastic fibers for advanced textiles

Biodegradable, Double Core, Porous Microstructured Fiber as a Smart Hypodermic Needle

Efficient Light Transmission and Illumination
Efficient Light Collection
Microfluidics
Release of Therapeutics

How to suspend inner core in the air?

M. Skorobogatiy et al., Optics Letters, October (2006);
Fiber Preform Fabrication

two cellulose butyrate cores (n=1.48)

separated with

hydroxypropyl cellulose powder (n=1.34)
Fiber Crosssection and Structure

- Inner core
- Particles suspending inner core in air
- Air channel
- Outer core
Optical Transmission Properties

Transmission loss 1-2 dB/cm
Material loss at 630nm is 0.4dB/cm

After 3cm of propagation

Powder particles separating the cores
Material loss of cellulose butyrate

Transmission window for medical applications. Fiber length of several meters.
Changes in the Fiber Transmission Properties when Submerged in Deionized Water
Changes in the Fiber Transmission Properties when Submerged in Deionized Water
When removed from a recipient after 24 hours of experiments, one observes unconstrained water evaporation along the whole fiber length with an evaporation rate of ~0.5mm/min.
Conclusions

• While biocompatible/biodegradable materials are considered more suitable for a relatively gentle fiber spinning process, we have demonstrated that some bio-friendly materials can be suitable for industrially robust fiber drawing.

• It is possible to incorporate microstructure into bio-friendly fibers.

• Fibers with dissolvable microstructure can be used to implement advanced functions such as drug release.
Acknowledgements

- Prof. C. Dubois
- Prof. S. Lacroux
- Prof. N. Godbout
- Res. Assoc. Y. Gao
- Post-Doc E. Pone
- PhD A. Dupuis
- MSc N. Guo

- Canada Research Chair Foundation
- Canadian Institute for Photonics Innovations