Extruded TOPAS hollow-core anti-resonant fiber optimized for THz guidance at 0.9THz

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Rationale and objective:

In the past decade, many researchers attempted to design and fabricate waveguides for THz guidance paving the way to integrated THz systems and related applications such as imaging, microscopy, quantum-cascade lasers, monitoring of chemical reactions and medical endoscopy of internal organs. This research work has focused on optimizing the transmission and minimizing the dispersion of THz waveguides. We propose and demonstrate a hollow-core anti-resonant fiber for the THz regime that extruded by conventional 3D printer.

Summary: In this work we exploit the flexibility of this manufacturing process to improve the fiber performance of a hollow core TOPAS fiber. Simulations based on the finite element method (FEM) with a perfectly matched layer (PML) boundary have been used to investigate the loss profile of the fundamental core mode: by increasing the core size and decreasing the struts thickness, the fiber attenuation improves, while the transmission window increases. A nozzle designed using an optimized simulation model was 3D-printed and used for the fiber fabrication. The resulting fiber exhibited a record low loss for a polymer suspended hollow core fiber of 2 dB/m at 0.85 THz

Outcome: We propose and demonstrate a hollow-core anti-resonant fiber for the THz regime that extruded by conventional 3D printer. In this work, we create a 3D printer nozzle for fiber fabrication. The simulation models were used to optimize the nozzle structure. Also, we present the thermal and the material flow simulation results that confirming the possibility to use this nozzle design as a die for the fiber extrusion. We demonstrate that a new procedure in fiber extrusion process which able to control the fiber structure. The experimental results done on THz time-domain spectroscopy (TDS) technique were used to confirm that our proposed fiber can be guided in THz regime.

Related publications:

1. Natthawat Phanchat, Wanvisa Talataisong, Nicholas Klokkou, Ratchapak Chitaree, Vasilis Apostolopoulos, Martynas Beresna, and Gilberto Brambilla, "Extruded TOPAS hollow-core anti-resonant fiber optimized for THz guidance at 0.9THz," Opt. Express 30, 13059-13069 (2022)