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THE USE OF HOLLOW OPTICAL WAVEGUIDES FOR THE TRANSMISSION OF UV LASER RADIATION

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Introduction. The performance of conventional solid-core silica optical fibers in the UV spectral range is limited due to factors such multiphoton absorption and solarization along with the increasing material absorption and Rayleigh scattering. In response, researchers have been exploring alternative approaches, such as hollow core fibers, for UV light delivery. These fibers possess a hollow core filled with air, an inert gas, or kept in a vacuum, allowing the elimination of absorption loss in the core and the avoidance of nonlinear effects. Consequently, hollow core fibers offer improved UV light transmission over longer distances and enable the handling of high-energy laser pulses. The unique properties of hollow core fibers make them attractive for a variety of applications, including UV light generation, Raman spectroscopy, trapped-ion manipulation, and high-precision micro-machining [1,2]. However, optimizing the fiber characteristics and developing optical components is crucial to further explore the potential of these fibers in the UV region. In particular, lensed hollow optical fibers are essential for many applications, such as optical sensing, optical coupling, and laser trapping [3]. Therefore, fabricating such components and studying their influence on UV light input and output is of paramount importance.

The main part. Using Comsol Multiphysics Ray Optics software, hollow optical fibers with core diameters of 10, 100, and 250 microns were modeled to investigate their behavior with respect to input and output of UV radiation. The power of the input and output was calculated for each fiber. Microlenses with various shapes were also modeled at the end of the fiber to control the input and output of radiation and the beam profile was analyzed for different beam setups and positions. Furthermore, a setup utilizing a CO_2 laser was established to create microlenses by focusing the beam and adjusting the fiber position with a XYZ stage and microscope, while controlling the exposure time and power.

Conclusions. The behavior of hollow optical fibers for UV radiation input and output has been analyzed. The best input angles were determined using the created model, and the influence of core diameter on UV radiation input was investigated. The losses in the fibers were evaluated by analyzing the input and output powers. Microlenses were evaluated for their efficiency in inputting and outputting UV radiation from the hollow fibers using both ball and hemispherical microlenses. Hemispherical microlenses were fabricated at the end of hollow fibers with different diameters using a CO_2 laser, and the laser regime for their shaping was determined.

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