Record power transmission of intense 343 nm UV radiation in a single-mode inhibiting coupling hollow-core fiber exceeding 20W of 10-ns pulses

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Silica fibers are successful at delivering high-power high-energy signals in the near-infrared and visible but suffer from high absorption and color formation in the UV spectrum. Hollow-core negative-curvature anti-resonant fibers are promising alternatives as UV radiation has a low overlap with the guiding microstructure. This type of fibers is promising as pulsed UV radiation can be delivered with a few tenths of dB/m transmission loss[1,3]. However, their power scaling is notably hindered by the power handling of the thin capillary microstructure. Single-mode tubular anti-resonant fibers were reported delivering 106mW 20ps 355ns pulses with 66% coupling efficiency over 1m of fiber[1], 13.75mW 17ns 266nm pulses with 40% transmission over 2m of fiber[2], and ~180mW 350fs 343nm pulses with ~52% transmission over a 5 m long fiber[3]. We report here 2 orders of magnitude of gain on this state of the art, with on a record single-mode delivery of 23.3W (155µJ) with 89.1% transmission from a 343 nm, 10 ns, 150 kHz laser source. Fig. 1(left) depicts the experimental setup for this record UV beam fiber transport experiment. The used Flex-UV laser source developed by BLOOM Lasers delivers a 343nm single-mode signal (M^2=1.04) and was parametered to deliver a 10ns-long 150kHz diverging output. Two standard fused-silica plano-convex lenses of 300mm and 100mm focal length shaped the beam down to 19µm, the mode-field diameter of the fiber LP_{01} mode, see Fig. 3. The fiber was fabricated by the stack-and-draw technique. The 2m-long hollow core cladding fiber cladding is composed of 8 non-touching tubes with a diameter of 11 µm and a thickness of 600 nm. The tubes are arranged to form the surround of a hollow core with a diameter of 27 µm. The endface of the fiber is shown on the right of Figure. 1. The fiber power handling is also presented on Fig. 1. The delivery of up to 23.3W is reported with a 90.0% average combined coupling and transmission efficiencies but notably peaking at 95.6% at 5.63W. The fiber output mode was imaged onto a CMOS camera using a +50mm-focal-length lens, four tilted wedges and neutral density filters. The single-mode output maintains over the power range as reported in Fig. 1.

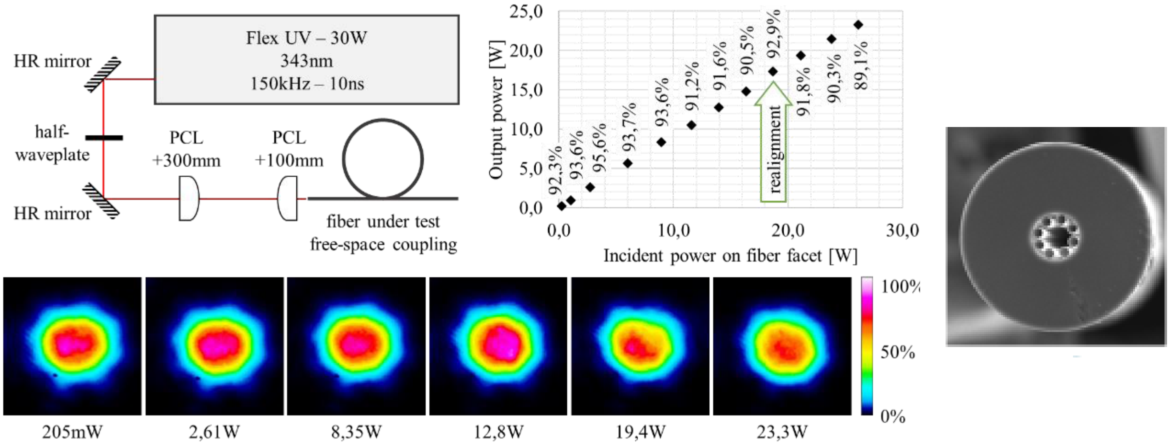

Figure. 3 : Power scaling: Schematic of the optical set-up; HR: High-Reflection; PCL: Plano-Convex Lens (top right), output against input with transmission coefficients (top right) with corresponding output beam profile from a CMOS camera (bottom).. Right : end face of the hollow core fiber

In conclusion, we have demonstrated thanks to the use of a state of the art high power UV fiber laser and an ultra-low loss IC-HCPCF, we managed to add 2 orders of magnitude on the power handling of fibers in the UV range, delivering more than 23 W of UV light at 343 nm on 2 m of IC-HCPCF.

References

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