

# A Twisted Shaped Cladding Light Stripper by CO<sub>2</sub> Laser Processing For High Power Fiber Lasers and Amplifiers

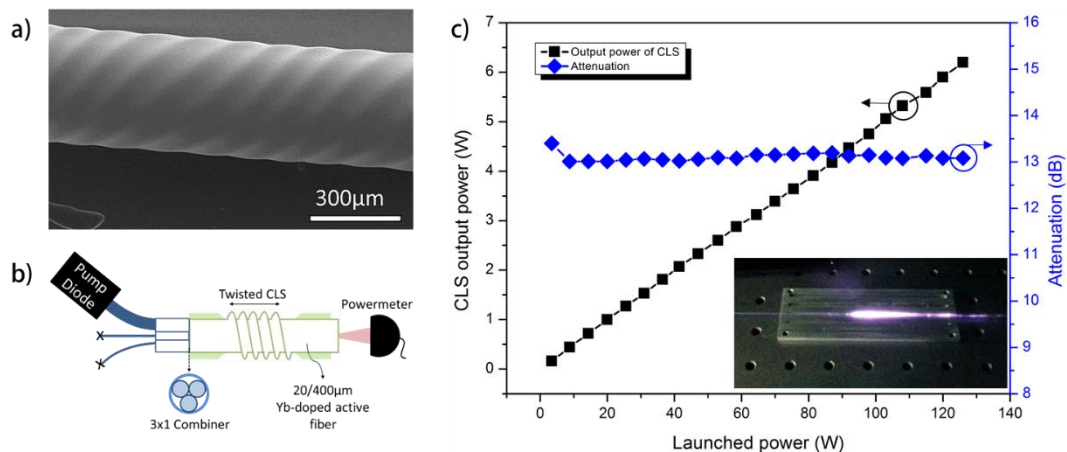
Bartu Şimşek<sup>1,2</sup>, Elif Uzcengiz Şimşek<sup>1,2</sup>, Yakup Midilli<sup>1,2</sup>, Bülend Ortaç<sup>1,2</sup>

1. Department of Material Science and Nanotechnology, Bilkent University, 06800 Ankara, Turkey

2. National Nanotechnology Research Center, Bilkent University, 06800 Ankara, Turkey

Applications of high power lasers and amplifiers have been increasing because of its superior properties such as high wall-plug efficiency, excellent beam quality, and reliability [1]. Despite advances in high power fiber components, there is still component reliability based challenges on extraction process of unwanted cladding light [2]. There are several techniques to extract the cladding light from the fiber laser system such as high index polymer coating that of working principle is violating the total internal reflection [2], roughened cladding surface which uses the scattering to eliminate the cladding light [3], soft metal coating to absorb the cladding light [4] and CO<sub>2</sub> laser processing of cladding to disturb the light path with the structural manipulations and strip the unwanted light from these structures. There are some limitations for each case. The high index polymer CLS are limited by the thermal degradation of recoated polymer [4]. For the roughened or etching CLS, even though very high attenuations levels were achieved, the roughing or etching process decrease the fiber strength. This could create undesired problems such as heat localization and microcrack formation on cladding wall. Here, we present novel method for practical, robust, compact, and all glass cladding light stripper fabrication on Ytterbium (Yb) doped octagonally shaped double clad fiber (DCF).

In the experiment, carbon dioxide (CO<sub>2</sub>) laser heated Yb-doped octagonal shaped DCF fiber is twisted by using AFL's LAZERMaster (USA-Japan) laser splicing machine. The surface of the DCG gets a twisted pattern since one of the fiber holder was rotating and the other one was fixed and the SEM image of this pattern is shown in Fig.1a. In this component, using 24 times 850µm-long twisted segment, 20mm-long CLS is fabricated. The performance of the twisted CLS was analyzed at the experimental setup shown in Fig.1.b. The output fiber of the diode laser (Dilas) having 200/240µm core/clad diameter is integrated to the cladding of 30cm DCF with 3x1 pump combiner. As a result of power analysis, 95% of the 119W input power was stripped with twisted CLS. The attenuation values and the CLS output power versus launched power are shown in the Figure 1.c. Also, the inset image at Figure 1.c represents the light distribution of the twisted CLS. It is obvious that light extracted from the CLS is homogenous and the attenuation is also stable with increasing launched power.



**Fig. 1** (a) SEM image of the twisted pattern on Yb-doped DCF. (b) Schematic of the power analysis setup. (c) Twisted CLS output & attenuation vs. launched power graph. (inset) IR camera image of the twisted CLS.

In conclusion, the twisted shaped robust and compact CLS is successfully fabricated by using CO<sub>2</sub> laser source. We achieved stable 13dB attenuation with 20mm-long twisted CLS. This new technique is efficient, easy to apply and could eliminate the thermal limiting problems of the polymer based CLS.

## References

- [1] D. J. Richardson, J. Nilsson, and W. A. Clarkson, "High power fiber lasers: Current status and future perspectives", *JOSA B, Opt. Phys.*, **27**(11), 63–92, (2010).
- [2] Wetter A., Faucher M. and Sévigny B., "High power cladding light stripper", *Proc. of SPIE*, **68**, 687327, (2008)
- [3] A. Kliner, Kai-Chung Hou, M. Plötner, Ch. Hupel, Th. Stelzner, T. Schreiber, R. Eberhardt, A. Tünnermann, "Fabrication and evaluation of a 500 W cladding-light stripper", *Proc. of SPIE*, **8616**, (2013).
- [4] Babazadeh, A., Nasirabad, R. R., Norouzey, A., Hejaz, K., Poozesh, R., Heidariazar, A. & Lafouti, M., "Robust cladding light stripper for high-power fiber lasers using soft metals". *Applied optics*, **53**(12), 2611-2615, (2014).