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► **To cite this version:**

Martin Maurel, Matthieu Chafer, Foued Amrani, Benoît Debord, Clemens Hönninger, et al. 50 fs compression of UV laser using IC-HCPCF. Conference on Laser and Electro-Optics /Europe (CLEO/Europe-EQEC 2019), OSA, Jun 2019, Munich, Germany. Paper CF-P.36. hal-02330879

HAL Id: hal-02330879

<https://hal.science/hal-02330879v1>

Submitted on 23 Nov 2020

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50 fs compression of UV laser using IC-HCPCF

M. Maurel^{1,2}, M. Chafer^{1,2}, F. Amrani¹, B. Debord^{1,2}, C. Honninger³, F. Gerome^{1,2}, E. Mottay³ and F. Benabid^{1,2}

¹GPPMM Group, Xlim Research Institute, CNRS UMR 7252, University of Limoges, France. ²GLOphotonics SAS, Limoges, France

³Amplitude Systèmes, Pessac, France

One of the timely challenges in the on-going and outstanding progress of high power ultra-short pulse (USP) lasers [1] is the development of USP lasers that emit in the UV spectral range whilst combining ultra-short duration, beam quality and high power and/or energy levels. Near infrared (NIR) USP lasers such as those based Ti:Saph or Yb materials exemplify this progress by exhibiting high energy/power and ultra-short pulse duration in a table-top turn-key systems. Furthermore, USP emitting in the UV by frequency-tripling these NIR USP lasers became now readily available thanks to their high peak powers. This frequency up-conversion is achieved in a simple and efficient way as illustrated with the commercially available ultrafast lasers emitting several μ Joules energy-level pulses at wavelengths centered on 343.3 nm. However, their pulse-width are limited to a few hundred of femtosecond, which are ultimately limited by the NIR laser gain spectrum. Consequently, developing sub-100 fs UV USP lasers requires based on third or fourth harmonic NIR USP requires spectral broadening and post-compression means.

Here, we report on the compression of a frequency-tripled Yb USP laser using an inhibited-coupling guiding hollow-core photonic crystal fiber (IC-HC-PCF) from 250 fs to 50 fs. This compression is based on the spectral broadening from \sim 3 THz to 60 THz of a laser emitting at 343.3 nm through 3.5 m air-filled or 0.7 m argon-filled IC-HCPCF.

Fig. 1(a) shows the micrograph, transmission and loss spectra of the used IC-HCPCF. The fiber is a tubular amorphous lattice cladding with a 40 μ m diameter hypocycloid core-contour core diameter. The losses at 343.3 nm were found to 500 dB/km. The set-up (Fig. 1(b)) is composed by a laser emitting at 343.3 nm with a pulse duration of 250 fs and a repetition rate of 200 kHz. The 4.5 μ J pulse is coupled in a fiber contained in a gas cell to control, thanks to the pressure management, both the broadening via Self-Phase Modulation (SPM) and also the Group-Velocity Dispersion (GVD) of the fiber. Figs. 1(c) shows the spectrum of the input laser (blue curve) along with the SPM-broaden spectrum (red

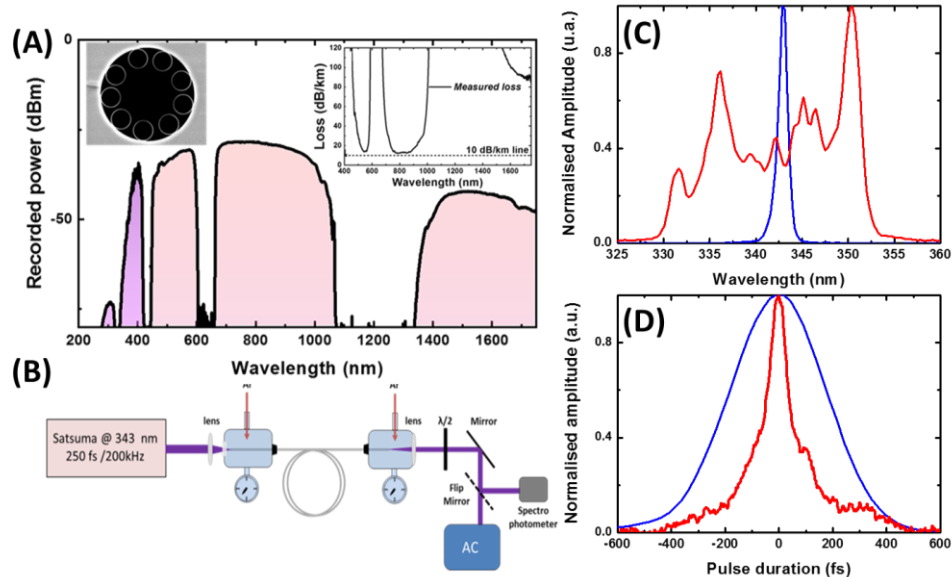


Fig. 1. (A) The IC-HCPCF transmission spectrum over 200-1750 nm range, the IC-HCPCF loss spectrum over 400-1750 nm range (top right inset), and the IC-HCPCF micrograph (top left inset). (B) Experimental set-up of the experiment. (C) Input spectrum (blue curve), broaden spectrum (red curve) for to 0.7 m long and 15 bar argon-filled fibre. (D) Measured input autocorrelation trace (blue curve) measured, autocorrelation trace of the post-compressed (red curve) thanks to 0.7 m and 15 bar of argon.

curve) for input energy of 4.5 μ J. Fig. 1(d) shows the measured autocorrelation traces for the input laser (blue curve) and the fiber output beam after being reflected off a negative GDD mirror (red curve). The spectrum broadens \sim 20 fold from 3 THz to more than 60 THz, whilst the pulse duration is narrowed from 250 fs to 50 fs.

This work is funded through PIA 4F project and the region of Nouvelle Aquitaine.

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