1 GHz Passively Modelocked All-Polarization-Maintaining Thulium-Doped Fiber Laser

C Cuadrado Laborde[1,2], H Muñoz-Marco[3], P Perez-Millán[3], J L Cruz[4], A Diez[4], and M V Andrés[4]

[1] *Grupo de Óotica y Fotónica, IFIR (CONICET-UNR), Rosario, Argentina*
[2] *Pontificia Universidad Católica Argentina, Facultad de Química e Ingeniería, Rosario, Argentina*
[3] *FYLA, Valencia, Spain*
[4] *Universitat de València, Valencia, Spain*
Contact Email: christian.cuadrado@uv.es

High-performance passively modelocked ultrafast lasers with repetition frequencies ranging from several hundred MHz to GHz have been the subject of extensive research. They play a crucial role in a variety of applications, including high-speed optical sampling, frequency metrology, and optical arbitrary waveform generation. Recent research has shown that accessing the mid- to far-infrared spectral region through nonlinear frequency conversion is possible by using ultrafast lasers operating at 2 um [1]. Since major bands of many different gas molecules can be seen in this spectral region, it is therefore envisaged that the development of these laser sources is highly desirable for frequency metrology and molecular spectroscopy applications. These characteristics would benefit of a full polarization-maintaining (PM) fiber optic assembly due to compactness, high beam quality, robustness, and resistance to harsh environments.

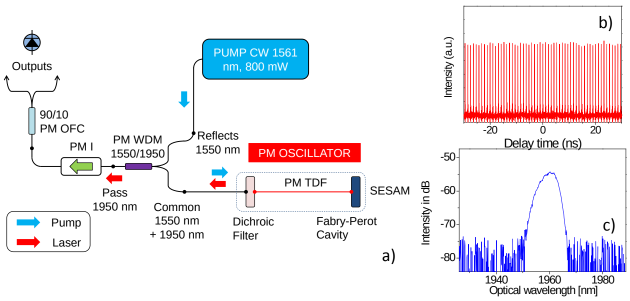

Figure 1: a) Laser setup, b) output light train, and c) optical spectrum

In Fig. 1a, we show the experimental setup, consisting of a short Fabry-Perot (FP) cavity and 100 mm long PM thulium-doped fiber (PM TDF, NUFERN PM-TSF-5/125, 340 dB/m at 1560 nm). This FP cavity is enclosed at one end by a semiconductor saturable absorber mirror (SESAM, BATOP®, 1900–2080 nm range, relaxation time $t = 10$ ps); while at the other end there is a dichroic filter (reflectance of 0.99 at 1940 nm and transmission > 0.9 at 1561 nm). The cavity is resonantly pumped by a CW laser (1561 nm, 820 mW) via a 1550/2070 nm PM wavelength division multiplexer (WDM). In Fig. 1b we show the output train at 947 MHz for a pump power of 339 mW and in Fig. 1c, the optical spectrum centered at 1960 nm with a FWHM of 6.2 nm is depicted. The average power measured at the 90/100 output of the optical fiber coupler (PM OFC) was 15.5 mW. We also indirectly measured the temporal width of the output light pulses, since the product of peak power times the average power precludes a direct measurement by an intensity autocorrelator. To this end, by propagating the output light pulses by a 210-m-long optical fiber of known dispersion (LEAF, 34.15 ps/nm/km), we inferred a FWHM light pulse duration at the output of the oscillator of 570 fs.

Acknowledgements: European Union, project IPN-Bio (H2020-MSCA-RISE-2019-872049).

References

[1] J Zhang, K F Mak, N Nagl, M Seidel, D Bauer, D Sutter, V Pervak, F Krausz and O Pronin, Light Sci. Appl. **7**, 17180 (2018)