Chalcogenide fibers for supercontinuum generation and methane spectroscopy near 8 µm.

R. Bizot[1], F. Désévédavy[1], A. Lemière[1], E. Serrano[1], D. Bailleul[1], B. Kibler[1], I. Tiliouine[2], S. Février and F. Smektala[1]

[1]ICB Laboratoire Interdisciplinaire Carnot de Bourgogne (ICB), UMR 6303 CNRS-Université de Bourgogne, Dijon, France

[2]XLIM, UMR 7252 CNRS-Université de Limoges, Limoges, France

e-mail: Frederic.Smektala@u-bourgogne.fr

Over the last decade, there has been a strong interest in the development of supercontinuum (SC) sources based on mid-infrared (mid-IR) optical fibres [1-3]. These broadband light sources take advantage of the spectral broadening of high-intensity laser pulses in infrared optical fibres typically made of glasses such as chalcogenides, which offer the widest transmission window and the highest non-linearity [4]. Beyond their spatial coherence and high brightness, mid-infrared SC fibered sources now cover the same wavelength ranges as some thermal sources with superior performance for spectroscopic applications [5]. In the spectral region between 2 and 16 µm, molecules exhibit fundamental vibrational resonances and characteristic absorption bands corresponding to their spectroscopic fingerprints. Furthermore, this spectral range covers the atmospheric transparency windows 3-5 µm and 8-14 µm. This is particularly interesting for applications such as greenhouse gas detection and chemical detection.

In this work, we demonstrate the fabrication of optical fibres based on chalcogenide glasses belonging to the Ge-Se Te ternary system. These fibers have been demonstrated adequate for wide SC generation and have been implemented in an experimental set up for methane detection between 7 and 8 µm with a detection limit of 14 ppm. The results are compared with the theoretical absorptions coming from the available spectra data bases. Finally, we discuss the materials aspect, the fiber drawing, the pumping schemes and the spectroscopic considerations together with the related prospects.

Acknowledgement: *This work was supported by National Grant France 2030 ISITE-BFC program, contract ANR-15-IDEX-03 and the Council of the French Bourgogne Franche-Comté region*

References

[1] C. R. Petersen, U. Moller, I. Kubat, B. Zhou, S. Dupont, J. Ramsay, T. Benson, S. Sujecki, N. Abdel-Moneim, Z. Tang et al., *Nature Photonics* 8 (2014) 830-34. https://doi.org/10.1038/nphoton.2014.213.

[2] Z. Zhao, B. Wu, X. Wang, Z. Pan, Z. Liu, P. Zhang, X. Shen, Q. Nie, S. Dai, and R. Wang, *Laser & Photonics Reviews* 11 (2017) 1700005. https://doi.org/10.1002/lpor.201700005

[3] A. Lemière, R. Bizot, F. Désévédavy, G. Gadret, J.-C. Jules, P. Mathey, C. Aquilina, P. Béjot, F. Billard, O. Faucher, B. Kibler, and F. Smektala, *Results in Physics* 26 (2021) 104397. https://doi.org/10.1016/j.rinp.2021.104397.

[4] G. Tao, H. Ebendorff-Heidepriem, A. M. Stolyarov, S. Danto, J. V. Badding, Y. Fink, J. Ballato, and A. F. Abouraddy, Infrared fibers, *Adv. Opt. Photon*. 7 (2015) 379–458. https://doi.org/10.1364/AOP.7.000379

[5] I. Zorin, J. Kilgus, K. Duswald, B. Lendl, B. Heise, and M. Brandstetter, *Applied Spectroscopy* 74 (2020) 485–493.