Compact All-fibre Wavelength Standards based on Micro-structured Fibres

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Classical passive and active wavelength standards are based on bulk gas cells and optical components and on discrete control electronics and are consequently sensitive to external perturbations. These systems are not adapted for integration in transportable measuring instruments or for the realization of compact stabilized lasers, which are key elements in many critical systems, *e.g.* high-density optical fibre telecommunication links or space applications. The recent development of micro-structured fibres[1], in which the guided optical mode propagates in a hollow core opened the path to the possible development of compact all-fibre gas cells[2], in which the hollow core is filled with the gas and interact with the optical filed very efficiently. Ideal all-fibre gas cells require purely singlemode hollow core fibres and minimum Fresnel reflections to avoid any perturbation of the spectra lineshape. The all-fibre gas cell that we developed consists in a piece of hollow core fibre, which is butt-coupled on both extremities with a singlemode fibre, whose endface has an anti-reflection coating. The butt-coupling is achieved using an especially developed gas-tight connector adapter, allowing a simultaneous access to the hollow core for the gas filling and for the light coupling. In Fig.1 (left side) we show the transmission spectrum of a cell filled with acetylene $^{12}C_2H_2$ at a pressure level of ~100 mBar. This cell is ideally suited for applications as an internal wavelength reference in optical spectrum analyzers. This same technique was applied for the fabrication of a low pressure gas cell for non-linear spectroscopy purposes.

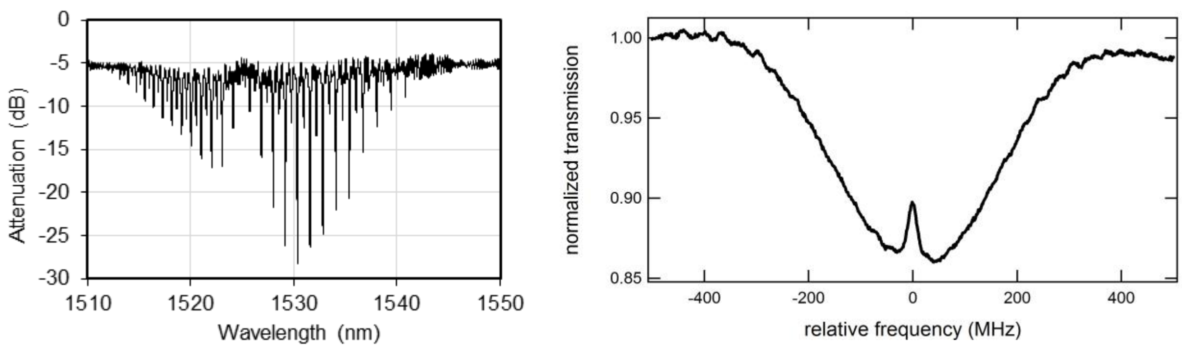

Fig. 1: Left : Absorption spectrum of a high pressure gas cell with $^{12}C_2H_2$ at a pressure of ~100 mBar. Right : Saturated absorption signal measured by using the same kind of gas cell at a pressure of 1 mBar.

Fig. 1(right side) shows the scan of the P17 line of $^{12}C_2H_2$ and the corresponding Lamb dip, whose spectral width is mostly limited by the transit-time broadening in the hollow core. This result was obtained by using a fully all-fibre pump-probe spectroscopy setup, easily extendable to the fabrication of all-fibre stabilized lasers. Details on the setup, techniques to coupling the light into the micro-structured fibres, gas filling and last results will be given at the conference.

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[1] F. Benabid, "Hollow-core photonic bandgap fibre: new light guidance for the new science and technology", Phil. Trans. R. Soc. A, doi:10.1098/rsta.2006.1908, 2006.

[2] P.T. Marty, J. Morel, T. Feurer, "All-Fiber Multi-Pupose Gas Cells and their Applications in Spectroscopy", Journal of Lightwave Technology, vol. 28, p. 1236-1240, 2010.