Stability of Optical Frequency References Based on Acetylene-filled Kagome-structured Hollow Core Fiber

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Abstract: A fiber laser at 1532 nm is stabilized to a sub-Doppler feature in acetylene inside hollow core kagome structured photonic crystal fiber. Short term stability is evaluated by beating against a Cr:forsterite laser-based frequency comb.

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Acetylene offers an excellent optical frequency reference in the telecommuications band. Hollow optical photonic crystal fibers filled with acetylene offer portability and optical intensities high enough to realize sub-Doppler features without the use of power build-up cavities. However, the small core sizes create transit-time limited linewidths of 20-40 MHz [1]. Kagome structures offer larger core sizes and therefore narrower sub-Doppler features, as shown in Fig. 1a, and exhibit less surface mode coupling than typically observed in photonic bandgap fiber [2, 3]. We have stabilized a narrow linewidth fiber laser (Orbits Lightwave) to a saturated absorption feature using an rf technique [3, 4]. Recently we have improved the signal-to-noise ratio to that shown in Fig. 1b by using polarization-maintaining optical fiber components and improved electronics. To measure the stability of the resulting locked fiber laser, we have compared the locked fiber laser to a Cr:forsterite laser-based comb referenced to a GPS-disciplined Rb clock [5]. The stability of the heterodyne beat between the comb and the stabilized fiber laser (Fig. 1c) is limited by the GPS-disciplined Rb clock at less than 1 s gate time, and is 4·10^-11 at 1 s.


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