Broadband Frequency Combs in Photonic-Belt Resonators

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Magnesium fluoride microresonators are a well-established platform for the generation of optical frequency combs[1]. The ultra-high finesse achievable in this material enables the large intracavity intensities required for cascaded four-wave mixing and the comb formation process. Here, we consider photonic belt resonators [2]: consisting of a thin belt ($\sim 5 \times 5\ \mu$m) machined into a MgF_2 cylinder. The resonators were fabricated using diamond turning techniques, achieving a finesse of 2×10^5. Owing to the restricted mode confinement provided by the belt, these devices support only a few whispering-gallery modes. This is crucial for the generation of frequency combs free from defects arising from linear mode interactions. By coupling 100 mW of power ($\lambda = 1550$ nm) into the resonator through a tapered fiber (waist $\sim 1\ \mu$m) and tuning into resonance, the generation of a frequency comb is observed (shown in Fig. 1). The resonator dimensions were engineered such that the resonator exhibited a small anomalous second-order dispersion (β_2) and a large third-order dispersion (β_3) [3]. This additionally permits the spectral extension of the frequency comb via a strong dispersive wave, and results in broadband frequency combs.

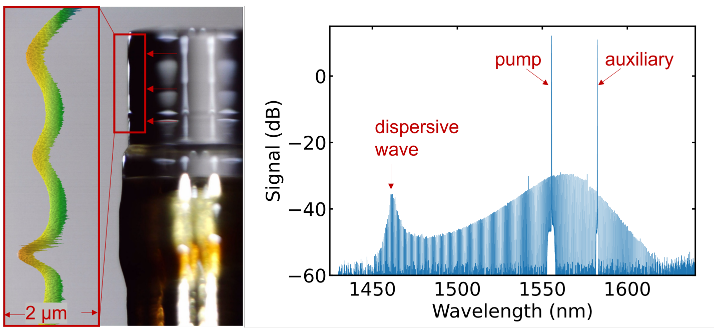

Figure 1: (Left) A photonic belt resonator, inset shows the surface as imaged by an optical profiler. (Right) Soliton spectrum excited around 1550 nm, stabilized by a laser at 1580 nm.

[1] A. Pasquazi *et al.*, *Phys. Rep.* **729**, 1–81 (2018).

[2] S. Grudinin and N. Yu, *Optica* **2**, 221–224 (2015).

[3] Jae K. Jang, Miro Erkintalo, Stuart G. Murdoch, and Stéphane Coen, *Opt. Lett.* **39**, 5503-5506 (2014)