Deterministic soliton crystal dual-comb generation in coupled nonlinear microcavities by tuning the coupling

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Microcavity based optical frequency combs (microcombs) can be applied for dual-comb spectroscopy [1] and ultra-fast optical ranging [2]. Compared to using two separate microcomb sources, dual-microcomb generation in a single system is desirable with higher stability and synchronization. Clockwise (CW) and counter-clockwise (CCW) modes in a microcavity have been proposed for dual comb generation [3,4], which has similar repetition rates and carrier frequencies since it is pumped by same continuous wave (cw) laser. Typically, the microcomb generation requires tunable cw laser pumps. When using two different tunable cw lasers in a single microcavity system, the synchronously tuning of the two pumps is a big challenge in experiments. In this paper, we propose a novel dual-microcomb generation scheme in the coupled microcavity system for the first time. Instead of tuning the pump cw laser, the microcombs are generated by tuning the coupling between the two coupled microcavities. In this case the tuning of the pumps is synchronous even if we use different pumps. Dual-microcomb generation with different repetition rates and carrier frequencies in the coupled microcavity system with simple and stable configuration is numerically demonstrated, which is promising for dual comb applications.

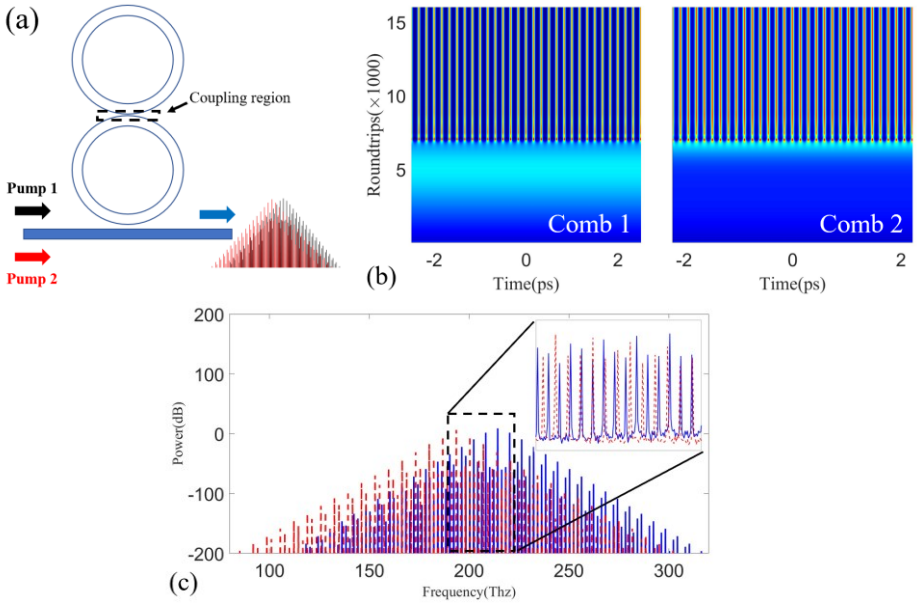

Fig. 1 (a) Dual-comb generation scheme in coupled microcavities. (b) Temporal evolution of the two microcombs. (c) Spectrums of the generated dual-micorcombs.

Figure 1(a) shows the dual-microcomb generation scheme in coupled nonlinear microcavities. Two coupled microcavities are pumped by two different cw lasers. Instead of tuning the frequency of the pump lasers, we tune the coupling coefficient at the coupling region to trigger two microcombs arising from pump 1 and pump 2. Figure 1(b) presents the numerically simulated temporal evolutions of the two microcombs. With the increase of coupling coefficient, both of the two microcombs emerge from cw background and the generated microcombs are in soliton crystal states. Fig. 1(c) shows the spectra of the generated dual-microcombs. The two microcombs have different carrier frequencies and different repetition rates as shown in the inner graph of Fig. 1(c).

References

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Abstract:

Dual-comb generation in a single microcavity system with multi-pumps is desired for compact scale and high stability. We propose a novel dual-comb

generation in a coupled nonlinear microcavity by tuning the coupling. **(35 words)**