Low-threshold laser from erbium-gain lithium niobate microcavity

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Integrated photonic circuits with nonlinear response are imperative in the boosting field of telecommunications and quantum networks [1]. Among all conventional nonlinear materials, lithium niobate (LiNO₃, LN) has drawn massive interest for its excellent performance in $\chi^{(2)}$ and commercialization compatibility. Thanks to the developed micro-machining techniques, on-chip lithium niobate structures with subnanometer roughness are now achievable [2,3], making integrated devices like frequency doublers, transducers and filters into reality. Besides these passive photonic circuits, the laser source on the LN integrated circuit leaves absence. Rare earth erbium is a well-acknowledged doping particle that produces the C-band laser. Combining photonic integrated circuits with erbium can pave the way towards the LN-based chip scale microlaser, which is crucial and groundbreaking on the integration of light sources and various functioned devices.

In the papers entitled “On-chip erbium-doped lithium niobate microcavity laser” [4] and “Microdisk lasers on an erbium-doped lithium niobate chip” [5], Liu et al. and Luo et al. present novel integrated photonic circuits with high-quality LN microdisks doped with erbium ions. The erbium ion is doped into LN during the crystal growth process using Czochralski method for uniform doping. Excessive micro-

machining processes achieved microdisk structures on LN wafer exceeding 10^5 quality factors. In their experiment, the telecom band down-conversion lasers from 1530 to 1560 nm are characterized as well as the up-conversion fluorescence. The reported laser threshold reached as low as 400 μ W when pumped at 974 nm. Moreover, they thoroughly analyzed the mode drift phenomenon modulated by pump power, heralding the potential of laser tuning.

The commercialization demand for LN-based photonic chips poses an intensive challenge to versatile functioned devices integrated with light sources. In all, both the aforementioned studies will rejuvenate active devices based on LN and benefit multiple applications including tunable lasers, modulators and parametric oscillators.

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