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High energy passively Q-switched laser on a CMOS platform

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High energy Q-switched lasers are highly desirable for various applications ranging from sensing, micromachining and medical applications especially in the long wavelength window (>1.8 µm). Such lasers are usually based on large benchtop solid-state or fibre systems. Integrated rare-earth doped medium [1-5] has been an excellent candidate for high energy pulse generation with high beam quality. In this work, we show CMOS compatible Q-switched laser around 1.9 µm with an on-chip output energy over 150 nJ in a footprint <10 mm^2. The pulse energy demonstrated in this work is comparable to passively Q-switched fibre lasers [6].

We utilize a cavity design that supports a large optical mode area (LMA) [7-9], which helps to increase the gain saturation energy allowing generation of high energy pulses without suffering from nonlinear effects. Moreover, unlike an LMA fiber laser the cavity design allows only fundamental mode propagation, and a high pump and signal mode overlap (>99%).

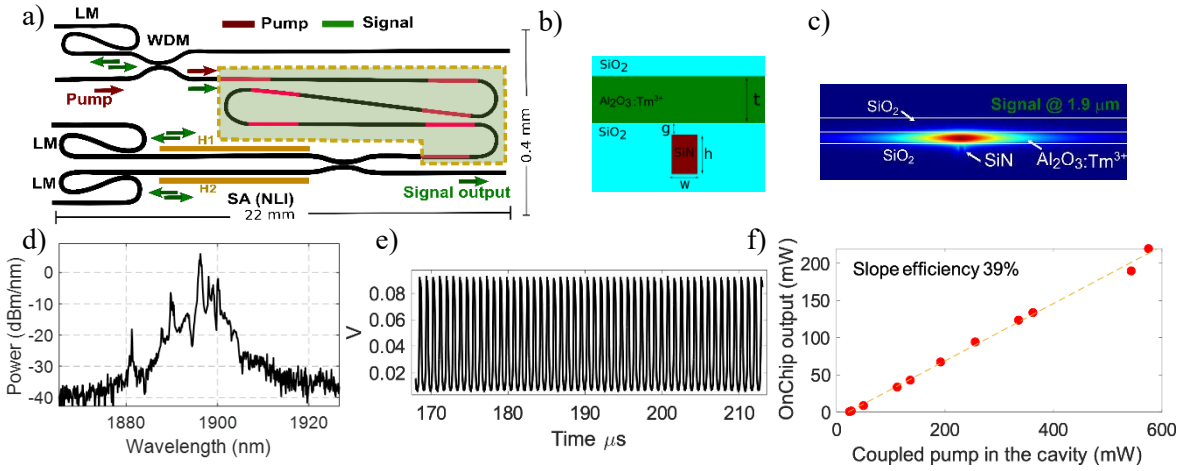

Fig.3 a), b) and c) The laser cavity, gain waveguide cross-section and signal mode profile. d), e) and f) The optical spectrum, pulse train of the Q-switched signal and the on-chip pump vs signal average power.

The schematic of the laser is shown in Fig.1a with the gain waveguide cross-section and the signal mode profile in Fig.1b,c. A thulium-doped alumina gain layer (Tm^{3+}:Al_2O_3) was deposited with RF sputtering technique. The device was pumped at 1.61µm. The measured Q-switched signal spectrum and temporal data are shown in Fig.1d, e. The pulse repetition rate ~1MHz, pulse width >200 ns and energy >150 nJ.

In conclusion, we have demonstrated large mode area based high energy CMOS-compatible Q-switched laser. Energy scaling seems possible with even larger mode area and optimized gain concentration. **Funding:** EU Horizon 2020 Framework Programme - Grant Agreement No.: 965124 Femtochip and Deutsche Forschungsgemeinschaft (SP2111) contract PACE:Ka908/10-1.

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