longer effective waveguide length compared with that realized by Shin and colleagues[17] (4 cm versus 3.3 mm), lead to a 0.6 dB end-to-end gain with a pump power just below the two-photon absorption threshold and only 0.1 dB below the condition of transparency (net gain equal to propagation loss).

According to Van Laer and colleagues[4], the linear gain is still smaller than predicted because there is acoustic energy leakage through the pedestal, and there is no clear solution proposed to significantly improve this. However, there is a clear way to reduce the reported optical loss of 2.6 dB cm^{-1}, which will automatically result in a longer effective length. The impressive 175% best on/off gains obtained by Van Laer *et al.*[4] can already be exploited for optical signal processing and for realizing complex all-optical functions[12] on a small footprint all-silicon chip. Because there is still a margin for improvement in the fabrication, an amplifying chip entirely made of silicon will certainly be proposed in the near future, paving the way to integrated laser sources.

A very interesting feature highlighted by Van Laer *et al.*[4] is the fact that the peak gain frequency is essentially given by the acoustic cavity resonance, which is purely fixed by the waveguide geometry. Any change of this geometry will impact on this resonance frequency and this could lead to a new class of sensing devices. More importantly, and unlike classical implementations in ordinary waveguides, the peak gain frequency is essentially achromatic because it is fixed by the geometry and the acoustic field can be stimulated using light with a distinct wavelength. This scheme has been implemented by Shin *et al.*[17] and Van Laer *et al.*[4] using cross-phase modulation. It could be used to realize more advanced functions, by shaping the acoustic vibration with a control optical-signal at a wavelength not subject to the limitations imposed by two-photon absorption. This paves the way for reconfigurable filtering and for all-optical logical gates.

A *son et lumière* show on a silicon chip is no longer just a technological promise, but is becoming a reality. ❐

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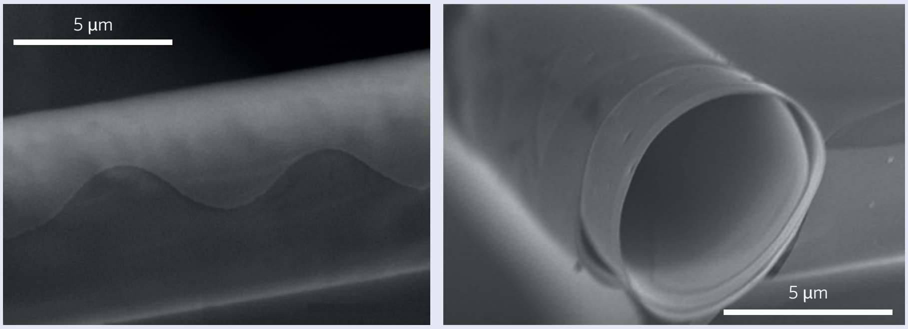
OPTOELECTRONICS

Semiconductor tube laser rolls out

A miniature laser made from a rolled-up tube of a thin semiconductor film looks set to offer silicon photonic integrated circuitry a new source of light. M. Hadi Tavakoli Dastjerdi and colleagues at McGill University in Canada say that their electrically-driven tube laser can be readily transferred onto a silicon platform without any performance degradation (*Appl. Phys. Lett.* **106,** 021114; 2015).

The Canadian team first fabricated a 54-nm-thick planar heterostructure film (featuring InGaAs/InGaAsP quantum wells as the gain media) on an InP substrate by molecular beam epitaxy. A tensile-strained 15 nm $In_{0.68}Ga_{0.32}As_{0.41}P_{0.59}$ layer was first deposited on top of the ultrathin film to make it roll up into a tube following its removal from the InP substrate by wet etching.

Once removed from the substrate, the team used the rolled-up film to form a free-standing microtube (pictured) with a high *Q*-factor and Purcell factor. The microtube (with a length of ~100 µm, a diameter of ~5 µm and a wall thickness of ~140 nm) was supported by two side pieces that served as n- and p-type contacts for the electrical injection current. The *Q*-factor of the microtube was estimated by numerical simulation to be ~800 for a wall-confined (24,1) resonance mode and the Purcell factor was calculated to be ~4.3. A small notch in the wall of the tube was used to control the direction of light emission out of the structure.



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The current–voltage characterization of the microtube showed a turn-on voltage for current flow of ~3 V, which is relatively high. It is thought that this is due to the large electrical resistance of the p-type contact. Ideally, the device should be annealed at ~800–900 °C to properly activate the implanted Be ions in the p-type contact, but no rolling of the film was observed for annealing temperatures above ~600 °C.

The electroluminescence was measured under a pulsed bias current at a temperature of 80 K. The emitted light was collected by an optical fibre and sent to a spectrometer. As the injection current into the tube was increased, the light emission around 1,485 nm showed a clear spectral narrowing for a current of ~1.05 mA, which coincided with a discontinuous change in the strength of the electroluminescence — a clear signature of the onset of lasing.

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