Mastering bandwidth: Researchers develop tunable, low-cost laser device

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A scanning electron microscopy image of the master and slave lasers integrated onto a silicon substrate to form a miniature tunable laser. Credit: 2010 IOP

Transmitting information as pulses of light through fiber-optic cables is the fastest and highest-bandwidth communications technology that exists today. Yet even this technology is being pressed to carry ever-greater quantities of information. One way to overcome this problem is to transmit light of different wavelengths simultaneously-an approach known as wavelength division multiplexing. However, the technique requires the use of tunable lasers, which are relatively expensive to produce. Hong Cai at the A*STAR Institute of Microelectronics and collaborators from Nanyang Technological University and Hong Polytechnic University have now developed a low-cost and tunable laser device made specifically for this purpose.

The new laser is constructed using microelectromechanical systems (MEMS) technology to achieve wavelength tunability. By moving a tiny mirror, the laser switches between different operating modes, each of which produces a different wavelength. This tuning capability is built into a 'master' laser, which injects laser light into a secondary 'slave' laser. The slave laser increases the power of the emitted light, suppresses unwanted wavelengths, and allows for the encoding of information by modulating the light intensity. The two-part configuration surpasses the performance of conventional tunable lasers, without increasing bulk or cost.

Cai and her co-workers first calculated how the power and wavelength of the master laser would affect the behavior of the slave laser. They found that the synchronization, or locking, between the two lasers can only be obtained for a certain range of powers and wavelengths, and that the slave output is always shifted to a longer wavelength than the master output.

The researchers then built and experimentally characterized the performance of their lasers. When integrated into a silicon chip (pictured), the laser device is only 3 mm long, 3 mm wide and 0.8 mm thick, and outputs light at wavelengths tunable over a range of 12 nanometers. Most importantly, compared with conventional single-laser devices, the new tunable laser has a narrower spectral distribution, lower noise and higher overall power.

Fabrication of the laser device using MEMS technology means that it can be made in large batches at low cost per device. The small size of the laser device also allows it to be more easily integrated into larger electronic and optical systems, including bandwidth-hungry communication networks. However, there remains considerable development work before this goal can be reached. "Our next steps will be to undergo a detailed physical study of laser operation, allowing us to optimize its performance and then to prototype it to meet the real needs of industry," says Cai.

More information: Cai, H. et al. Discretely tunable micromachined injection-locked lasers. *Journal of Micromechanics and Microengineering* 20, 085018 (2010). dx.doi.org/10.1088/0960-1317/20/8/085018

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