Improving lasers with microring mirrors

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(PhysOrg.com) -- We use lasers everyday, though many of us may not think about it. “Lasers are in a number of consumer products,” Lynford Goddard tells *PhysOrg.com*. “We have them in DVD players, printers, and in other products.”

Right now, many consumer products make use of linear Bragg reflectors for laser mirrors. However, as a desire for ever-smaller and more complex devices pervades society, some of these conventional lasers are too big to densely pack in a photonic integrated circuit. “Our goal originally was just to make a smaller device. We took the conventional linear Bragg reflector and rolled it on itself to save space,” Professor Goddard explains. He worked with Amir Arbabi, Young Mo Kang, Ching-Ying Lu and Edmond Chow at the University of Illinois at Urbana-Champaign to create a design integrating a distributed Bragg reflector inside a microring resonator.

“What we found,” Goddard continues, “was that our geometry solved other problems associated with the linear distributed Bragg reflector. Not only did we make a smaller device, but we were also able to engineer a more ideal spectral response. It was narrower and free of side mode ripple.” The results of the team’s work can be found in Applied Physics Letters: “Realization of a narrowband single wavelength microring mirror.”

“Bragg reflectors are found in telecommunication systems, sensors, diagnostic equipment – including medical equipment, as well as in consumer products,” Goddard says. “One of the issues, though, is that you can get ‘mode partition noise’ because there are several different wavelengths competing for power due to side mode ripple. Our design is such that only a single wavelength is strong. The other wavelengths are there, but they are greatly suppressed. This reduces noise, and allows for better spectroscopy, and would also be ideal in telecommunications applications.”

Microring resonators aren’t new. “This is a well-known device,” Goddard says. “However, we added the Bragg reflector, patterning it along a specific fraction of the circumference of the ring. This is what allows it to be reflective at exactly one resonance and not others.”

Goddard and his colleagues created the reflective microring structure using common materials. “We used materials already common in the semiconductor industry,” he explains. “The real novelty is in terms of device design.” Using materials that are already common and accessible also increases the chance that this new version of reflector could be put into wider use sooner than a device that requires the development of new materials.

Graduate student and lead author Amir Arbabi describes the long process involved in realizing this novel device: “We quickly developed an intitial device model, and then spent over two years refining it, developing new simulation methods, writing proposals to support the research, perfecting the fabrication process, and building the testing station.” He is also quick to point out that the work received the support of a NSF grant.

“Even though our original goal was to simply create a way to shrink laser devices, there are a number of uses for this design,” Goddard insists. The improved performance, along with the smaller size, is a real advantage. “This device will also be useful in metrology, medicine and telecommunications as well as in consumer products.”

More information: Amir Arbabi, Young Mo Kang, Ching-Ying Lu, Edmond Chow, and Lynford L. Goddard, "Realization of a narrowband single wavelength microring mirror," *Applied Physics Letters* (2011). Available online: link.aip.org/link/doi/10.1063/1.3633111