Multiple lasers could be replaced by a single microcomb

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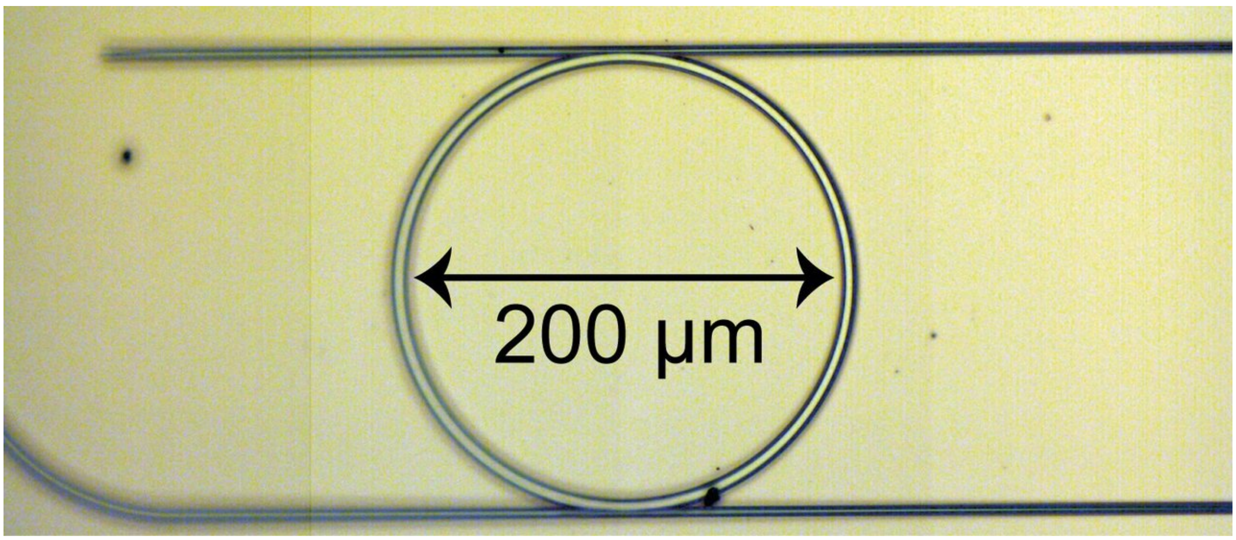

Microscope image of the microresonator device itself. Credit: Attila Fülöp

Every time we send an e-mail, a tweet, or stream a video, we rely on laser light to transfer digital information over a complex network of optical fibers. Dozens of high-performance lasers are needed to fill up the bandwidth and to squeeze in an increasing amount of digital data. Researchers have now shown that all these lasers can be replaced by a single device called a microcomb.

A microcomb is an optical device that generates very sharp and equidistant frequency lines in a tiny microphotonic chip. This technology was developed about a decade ago and is now reaching a maturity level that enables new applications, including lidar, sensing, timekeeping and of course optical communications.

The soul of a microcomb is a tiny optical cavity that confines laser light in space. Therefore, this technology provides a fantastic playground to explore new nonlinear physical phenomena. These conditions have now been utilised by researchers at Chalmers University of Technology, Sweden, in cooperation with researchers at Purdue University, USA. Victor Torres Company, Associate Professor at Chalmers, is one of the authors of a paper that was recently published in the journal *Nature Communications*.

"We observed that the optical frequencies of the microcomb interfered destructively over a short period of time, thus providing the formation of a wave inside the cavity that resembled a 'hole' of light. The interesting aspect of this waveform is that it yielded a sufficient amount of power per frequency line, which was essential to achieve these high-performance experiments in fiber communication systems," says Victor Torres Company.

The physical formation of these "dark" pulses of light is far from being fully understood, but the researchers believe that their unique properties will enable novel applications in fiber-optic communication systems and spectroscopy.

"I will be able to explore these aspects thanks to the financial support of the European Research Council (ERC)", says Victor Torres Company. "This is a bright start to better understand the formation of dark pulses in microresonators and their potential use in optical communications. The research could lead to faster and more power-efficient optical communication links in the future."

The results are the fruit of a collaborative effort between researchers at the School of Electrical and Computer Engineering at Purdue University, who fabricated the samples, and the group of Professor Peter Andrekson at the Photonics Laboratory at Chalmers, which hosts world-class experimental facilities for fiber-optic communications research.

"Our findings do not represent the first demonstration of a microcomb in fiber communications, but it is the first time that the microcomb has achieved a performance compatible with the strong demands of future communication systems," says Peter Andrekson, who is also one of the co-authors of the paper.

The main author is Attila Fülöp, who defended his doctoral thesis, "Fiber-optic communications with microresonator frequency combs," at the Photonics Laboratory in April.

"Working with the microcomb and this experiment has been a great experience. This proof-of-concept demonstration has allowed us to explore the requirements for future chip-scale data transmitters while at the same time proving the potential of this very exciting dark pulse comb technology," he says.

More information: Attila Fülöp et al, High-order coherent communications using mode-locked dark-pulse Kerr combs from microresonators, *Nature Communications* (2018). DOI: 10.1038/s41467-018-04046-6

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