The key to a more efficient nanolaser?

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"There are some discussions about the recent applications on photonic nanolasers and photonic integrated circuits based on photonic crystals," Toshihiko Baba tells *PhysOrg.com* in an email. Baba, a scientist at the Yokohama National University in Japan, has been working on improving the efficiency of photonic crystal nanolasers.

In "Photonic crystal nanolaser monolithically integrated with passive waveguide for effective light extraction," published in *Applied Physics Letters*, Baba and members of his team, Kengo Nozaki and Hideki Watanabe, describe how to increase light extraction efficiency using a nanolaser integrated with a passive waveguide, along with the MOCVD butt-joint technique.

"I think the MOCVD butt-joint technique itself is mature and can be done in any companies making communication wavelength lasers," Baba explains, referring metal-organic chemical vapor deposition. MOCVD is used mainly in thin films and other high-performance materials systems. Using the MOCVD technique in tandem with a nanolaser integrated with a passive waveguide can theoretically increase the efficiency of light extraction from the laser.

"I think it is an important result," Baba says in an email. He goes on to point out that there are discussions regarding applications offered by photonic nanolasers, as well as photonic ingrated circuits. He mentions single photon emitters being studied for quantum cryptography, uses involving optical RAM, and bio-chemical sensing. "All of them are used with input/output waveguides and other functional elements," he says.

Baba admits that the paper in question doesn't shed much light on experimental practicalities. "The integration of nanolaser and passive waveguide is dreamed of and illustrated by many groups. But lacking its technology, people have used the out-of-plane leaky light and evanescent-coupled light into adjacent fiber detector as light output." These light extraction problems could be solved, he believes with an improved setup.

In the experiments run using the setup, only four percent efficiency was achieved. "The main reason of the low value of four percent is caused by the optical setup we used for light detection," he explains. "By using a lensed taper fiber and optimizing the facet of the waveguide, both of which are extrinsic problems, the efficiency will be 10 times."

Baba says that this has been confirmed in a waveguide-type laser, and that the results of this other experiment will appear quite soon in another journal. Additionally, in the same issue of *Applied Physics Letters*, Baba and his colleagues report a demonstration of resonant photopumping using their integrated photonic nanolaser.

When all of the pieces are put together, continuous wave (CW) operation will be possible. "[A]ll optical lasing with high efficiency is expected," Baba says. He is optimistic about the prospects for the future of photonic nanlasers. "[N]ow the integration technology is available and the light is extracted and used in the photonic crystal integrated circuit." And when everything that his team continues to learn comes to light in other publications, Baba is confident that "the efficiency of photonic crystal lasers is sufficiently high as those of conventional best lasers."

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