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External Gain Improves Tiny Laser

TAEJON, Korea -- Because microcavity lasers are so small, they are extremely sensitive to perturbations, so it is difficult to pump the laser modes, for example, without degrading the microcavity.

Now researchers from the Korea Advanced Institute of Science and Technology have demonstrated a gain mechanism that is external to the microcavity, yet drives lasing modes.

Kyungwon An, director of the Center for Macroscopic Quantum-Field Lasers and a professor at the institute, and his co-workers Hee-Jong Moon and Young-Tak Chough constructed a microcavity resonator from a 200-µm-internal-diameter capillary, rhodamine dye and a 125-µm optical fiber.

They focused a frequency-doubled Q-switched Nd:YAG laser on a segment of the capillary center. The dye molecules absorbed the pump radiation and transmitted a percentage of their emitted light into the evanescent tail of the whispering gallery modes of the microcavity -- in this case, a section of optical fiber.

The majority of the whispering gallery mode was guided within the optical fiber resonator. Even though it was not directly pumped, the microcavity displayed lasing, first at 605 nm, then near 578 and 555 nm as the researchers increased the pump power.

These steps indicate the extension of the whispering gallery modes deeper into the fiber as the higher-order modes were excited.

Quantum playground

The researchers chose a cylindrical microcavity because it was readily available, but they have since moved on to microspheres.

"Now we routinely make extremely high-quality microspheres, 1000 times better in cavity quality factor than the microcylinder," An said. "We applied our evanescent-wave coupling idea to the microsphere and have also achieved laser oscillation, but with a much smaller number of dye molecules."

They hope to construct a micro-sphere laser with a single quantum dot or single atom.

The idea of evanescent-wave coupling has been known for some time, An said, but the researchers' work, which they reported in the Oct. 9, 2000, issue of *Physical Review Letters*, is the first to demonstrate its actual use in a microlaser.

Manipulating the characteristics of this type of laser could provide excellent insight into the processes of quantum electrodynamics.

For such investigations, he said, "the microcavity is an ideal playground."

Richard Gaughan

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