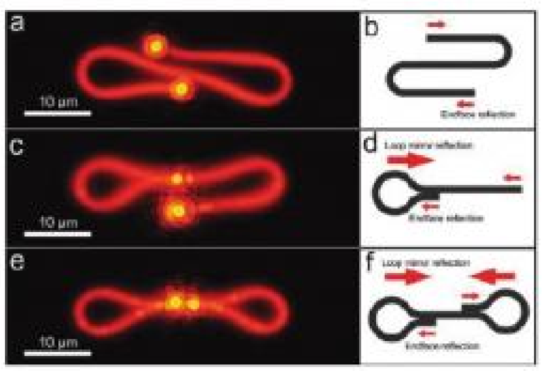
Scientists make single-mode laser out of a single nanowire

February 28 2011, By Lisa Zyga



(A, C, E) Photoluminescence microscopy images of single-nanowire lasers in three configurations. (B, D, F) The thin arrows represent endface reflection with low reflectivity, while the thick arrows represent loop mirror reflection with high reflectivity. Image credit: Yao Xiao, et al. ©2011 American Chemical Society.

(PhysOrg.com) -- Although lasers come in all shapes and sizes, one of the most recent laser designs is especially intriguing, since it's made of just a single nanowire. Due to its small size and simplicity, the single-nanowire laser could be used as a nanoscale coherent light source for applications in optical communications, sensing, and signal processing.

The team of researchers, Yao Xiao, et al., from Zhejiang University in Hangzhou, China, and Peking University in Beijing, has published their study on a new single-nanowire laser in a recent issue of Nano Letters. Although it's not the first laser made out of just one nanowire, it offers certain advantages since it operates in a controllable single-mode.

"Previously, single-nanowire lasers are mostly operated in multiple modes," coauthor Limin Tong of Zhejiang University told *PhysOrg.com*. "The single-nanowire laser reported in our work is single-mode, which is highly desired for practical applications."

Here, the laser's emission has a wavelength of about 738 nm (the upper end of the visible spectrum). The nanowire used to make the laser has a diameter of 200 nm, and a length of between of 50 and 75 µm. The researchers experimented with bending nanowires in different ways by peering under a microscope and folding the nanowire with fiber probes. For example, they folded nanowires so that they had loops at both ends, a loop at one end, and no loops.

To get the nanowire to act as a single-mode laser, the researchers excited the looped nanowire with a pulsed laser. As they explained, when the round-trip gain, which is sustained by feedback such as reflection, can compensate round-trip losses, lasing occurs. The researchers observed lasing in the single nanowires as two bright spots of light at both ends of the nanowire. They found that, for the nanowires that were folded into loops, the loops acted as loop mirrors, which not only offers the nanowire coupled cavities for mode selection, but also increases the nanowire's reflectivity and reduces the lasing threshold. Together, the high reflectivity and low threshold create a high-quality lasing cavity in the nanowire.

In addition, changing the size of the loops allows the researchers to tune the laser's wavelength. Using the fiber probes, the researchers could easily change the size of the loops. They found that decreasing the size of one of the loops changes the wavelength due to the reduction in the optical path of the lasing cavity.

The scientists hope that the single-nanowire laser, with its advantages of high mode quality and low lasing threshold, could enable new opportunities for practical applications of nanowire lasers. In addition, the study could provide a new design technique for fabricating low-threshold, single-mode lasers using other kinds of nanostructures.

"As a coherent optical source, this kind of nanowire laser does not only possess a miniaturized footprint (as many other nanowire lasers), but also offers single-mode laser output (difficult to realize in most other nanowire lasers but highly desired for practical applications)," Tong said. "Therefore, this kind of laser may offer great potential in applications such as nanoscale integrated optoelectronic circuits for optical data processing and optical sensing."

More information: Yao Xiao, et al. "Single-Nanowire Single-Mode Laser." *Nano Letters*. DOI:10.1021/nl1040308