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All-fiber Q-switched laser operates at 1 micron

Portable devices for communication, microscopy, precision machining and other applications could use the 1 micron source.

A compact all-fiber actively Q-switched laser operating at 1064 nm has been developed by a US team. A group from NP Photonics and the University of Arizona, Tucson, reached the difficult 1 micron region using a deliberately simple experimental set-up, with no coupling to external bulk components and a minimum of fiber components within the cavity. (*Optics Letters* **32** 8 897)

The next steps will be to develop similar lasers throughout the range 1030-1070 nm, increasing the power and accessible wavelength regions. "Such lasers could find use as portable sources for spacecraft communication and sensing, or in multiphoton and fluorescence microscopy, precision machining, fiber sensors, nonlinear frequency generation, optical time-domain reflectometry (OTDR), or as pulsed seeders for fiber amplifiers," Matthew Leigh of NP Photonics told optics.org.

A strongly absorbing active fiber doped with 6% ytterbium allowed the cavity length to be reduced to 3.5 cm. The active fiber was spliced between two fiber Bragg gratings, to act as mirrors, and a short section of standard nonpolarization-maintaining fiber. A commercial 976 nm diode laser pumped the cavity.

The Q-switch mechanism itself was a piezoelectric, which compresses the fiber and induces birefringence. In turn, the birefringence acts as a waveplate, changing the polarization state of the light in the fiber.

"One challenge was pressing a fiber with a piezo near a splice at a high repetition rate without breaking the fiber chain. Another was proper simultaneous tuning of the electrical signal and piezo offset," said Leigh. "And since 1 micron is out of the telecommunications L band, fiber component selections are more limited. This was important, since the laser was designed to use conventional fiber, rather than the exotic LMA fibers now typically used in pulsed fiber laser systems."

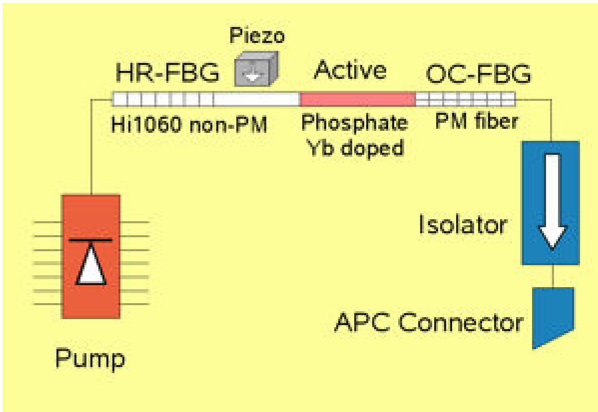
The team Q-switched their laser at a peak repetition rate of 700 Hz, which they say is significantly faster than other all-fiber Q-switched sources. The highest average peak power seen was 13.6 W, at a pump power of 185 mW and a repetition rate of 200 Hz. The peak power proved to be relatively constant below a repetition rate of ~500 Hz, and the experiment was run for several months with no adverse effects.

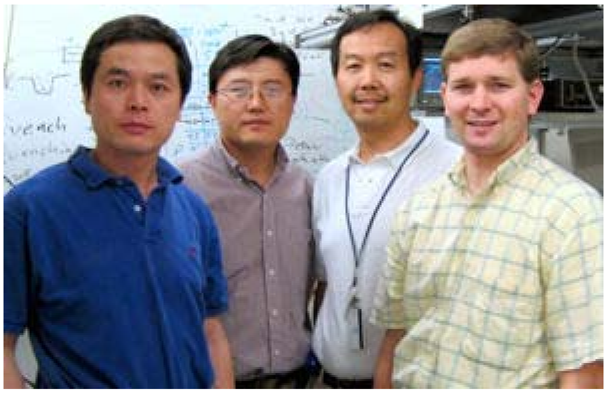
Having proved the concept, Leigh's team is ringing the experimental changes. "We have also made lasers successfully with Er-Yb co-doping, but it's the doping with Yb, as opposed to other ions, that produces just the resonance in the 1 micron region."

Other cavity dimensions have been tried too. "A shorter cavity length is better for single-frequency operation, but it increases the chance of breakage since the piezo will be closer to a splice," said Leigh. "Making the gain portion of the fiber shorter would also reduce the gain and therefore the power of the laser. So in practice, while the cavity can be made even shorter, it would be difficult to drastically reduce it without tradeoffs or the use of different methods."

About the author

Tim Hayes is a reporter for *optics.org* and *Optics & Laser Europe*.




(left to right: Shibin Jiang, Wei shi, Jei Zong, Matt Leigh)