Harvard University engineers demonstrate laser nanoantenna

September 6 2006

Engineers and applied scientists from Harvard University have demonstrated a new photonic device with a wide range of potential commercial applications, including dramatically higher capacity for optical data storage. Termed a plasmonic laser antenna, the design consists of a metallic nanostructure, known as an optical antenna, integrated onto the facet of a commercial semiconductor laser.

Spearheaded by two research groups led by Ken Crozier, assistant professor of electrical engineering, and Federico Capasso, Robert L. Wallace Professor of Applied Physics and Vinton Hayes Senior Research Fellow in Electrical Engineering, the findings are published in the journal *Applied Physics Letters*. The researchers have also filed for U.S. patents covering this new class of photonic devices.

"The optical antenna collects light from the laser and concentrates it to an intense spot measuring tens of nanometers, or about one-thousandth the width of a single human hair," says Crozier. "The device could be integrated into optical data storage platforms and used to write bits far smaller than what's now possible with conventional methods. This could lead to vastly increased storage capacities in the terabyte range (a thousand gigabytes)."

Writable CDs and DVDs are a popular means for storing and backing up data, but the storage density is limited by the resolution limit of conventional optics. The optical antenna offers a substantial improvement in spatial resolution, which in turn leads to increased storage density. While optical antennas are similar to conventional antennas used for wireless communications (Wi-Fi), they are much smaller in scale -- only a few hundred nanometers across. Moreover, optical antennas operate in the visible and infrared portion of the electromagnetic spectrum; these wavelengths are far smaller than the wavelengths used in Wi-Fi.

"This invention extends the reach of semiconductor lasers -- which have the greatest commercial penetration of all lasers -- into the nanoscale and down to dimensions much smaller than a wavelength," says Capasso. "This means the plasmonic laser antenna is potentially useful in a broad range of scientific and engineering applications, including near-field optical microscopes, spatially resolved chemical imaging and spectroscopy."

The new device integrates an optical antenna and a laser into a single unit, consists of fewer components, has a smaller footprint (takes up less space), and benefits from an improved signal-to-noise ratio relative to previous approaches. The inventors expect, with further development, its wide adoption and use in academic and research settings as well as in the high-tech commercial sector.

"Eventually, we envision the laser integrated into new probes for biology like optical tweezers -- which can manipulate objects as small as a single atom," says Crozier. "It could also be used for integrated-circuit fabrication or to test impurities during the fabrication process itself. One day, consumers might be able to back up three terabytes data on one disk."

Source: Harvard University