Carbon nanotubes give cheap fiberoptics a pulse

By Todd Morton | Published: November 04, 2008 - 02:47PM CT

Carbon nanotubes (CNTs) are making inroads into the world of lasers where, traditionally, exotic semiconductor materials have dominated. We recently reported on a new CNT composite that may have telecommunications applications, although that work focused on the matrix that the CNTs were embedded in. New work published in *Nature Nanotechnology* has shown that our relative inability to precisely control the growth of CNTs has turned into an advantage for laser applications—it can be leveraged to produce a saturable absorber that controls pulsed laser outputs over a much wider band than traditional semiconductor equivalents.

We'll start by taking a step back and looking specifically at the part of the laser that we're talking about. Telecommunications uses fiber lasers, where a standard laser diode is attached to a fiberoptics array that includes a highly doped section of fiber—in this case, the dopant being the element erbium (Er). The standard laser diode "pumps" the Er doped fiber, which in turn provides an output in the 1500nm wavelength range commonly used in the telecommunications industry.

A constant beam doesn’t do us much good for sending bits of data, so a saturable absorber is put in line which mode-locks the laser, producing the pulsed output that we’re after for communications. Saturable absorption is a material property where something will absorb light, but only to a point—once that point is reached, it will release a short, powerful burst of light and recover.

The details vary from material to material, and finding something that can be a saturable absorber at a useful wavelength of light and reasonably low power levels is no small task. Mix together intrinsic materials properties, designs rooted in the principles of quantum mechanics, exotic manufacturing techniques, and you end up with semiconductor structure that is both a saturable absorber suitable for telecommunications, and something that is incredibly expensive.

CNTs have shown their usefulness as a saturable absorber in the past, and researchers set out to assess the possibility that they could eliminate the need for expensive semiconductors. CNTs vary in diameter, which is usually a bad thing for precision optics and electronics. But, in this case, the variations are thought to contribute to a broad spectrum of absorption—a band of 40nm was possible, roughly an order of magnitude higher than that observed in semiconductor materials This would allow for wideband tunable laser communications.

The researchers pointed out the relative immaturity of their device, and suggest that things like pulse frequency could be improved upon by engineering the orientation of the nanotubes more precisely and eliminating impurities in the CNTs and matrix material. Regardless, characterization of the output was encouraging, suggesting that CNTs work well as a mode-locker for telecommunications.

As we continue to push more data around the world faster and faster, an efficient telecommunications infrastructure is a must. Optical computing will also need small, cheap components that don’t skimp on performance as well. Although CNTs look promising for both applications, much of this hinges on the economics of scaling up CNT production to meet the demands of all the new and exciting devices we’re seeing roll out of the laboratories around the world.

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