Photoluminescence in nano-needles

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Silicon is the workhorse among semiconductors in electronics. But in opto-electronics, where light signals are processed along with electronic signals, a semiconductor that is capable of emitting light is needed, which silicon can't do very well. Here gallium-arsenide (GaAs) is the workhorse, especially in the creation of light emitting diodes (LED) and LED lasers.

Scientists at the University of California, Berkeley have now grown GaAs structures into the shape of narrow needles which, when optically pumped, emit light with high brightness. The needles are approximately 3 to 4 microns long and taper at an angle of 6 to 9 degrees down to tips approximately 2 to 5 nanometers across.

These needles are not yet lasers; creating them will be the next step. This represents the first time a lab has been able to fashion GaAs into a defect-free crystal structure (technical name: wurtzite) exactly like this on a silicon substrate and without the use of catalysts.

Lead researcher Michael Moewe says that, in addition to optoelectronic devices, he expects the needles to be valuable in such applications as atomic force microscopy (AFM), where the sharp tips can be grown in arrays without further etching or processing steps. Some believe that AFM arrays, besides speeding up the recording of nearly atomic-resolution images of surfaces (allowing one to create atomic movies), might be used to create a new form of data storage by influencing the atoms in the sample. The needles also may be used in producing tip-enhanced Raman spectroscopy.

Raman spectroscopy is a process in which the energy levels of molecules are determined by shining light at a known frequency into the sample and then observing the frequency of the outgoing light. Delivering light from a sharp tip allows a much more targeted examination of the sample, possibly even permitting the spectroscopic study of single molecules.

The research will be presented at the 2008 Conference on Lasers and Electro-Optics/Quantum Electronics and Laser Science Conference (CLEO/QELS) May 4-9 at the San Jose McEnery Convention Center in San Jose, Calif.

Source: Optical Society of America