A key to the group's success has been the ability to isolate large amounts of very pure (6,5) SWNTs, based on a process developed by Huaping Liu and colleagues at the National Institute of Advanced Industrial Science and Technology and the Japan Science and Technology Agency. "We've shown that if you put in an impurity of (6,4) SWNTs, there's something about the junction between two dissimilar nanotubes that causes excitons to be irradiatively recombined, instead of separated and harvested for their current," said Strano. This happens even though (6,5) and (6,4) SWNTs have very similar bandgaps.

Strano acknowledges that this is a "humble advance" in photovoltaic research, because the efficiencies his group has measured to date for the nanocarbon devices are only about 0.1%. However, significant improvements can likely be made by combining the two nanocarbon materials in ways that maximize the surface area and produce continuous phases.

"We see this as a starting point—it expands the tools and the available technologies for the energy engineer to build new kinds of photovoltaic cells," Strano said. "It carves out a new space in photovoltaic technology."

Tim Palucka

Nano Focus

Vanadium oxide bronze nanowires show unprecedented metal–insulator transition

Researchers are working to identify materials that could one day replace silicon to make computing faster. Sambandamurthy Ganapathy, Sarbajit Banerjee, and their colleagues at the University of Buffalo have found a vanadium oxide bronze whose unusual electrical properties in nanowire form, including unprecedented metal–insulator transitions, could increase the speed at which information is transferred and stored.

In the August 17 online edition of *Advanced Functional Materials* (DOI: 10.1002/adfm.201201513), the researchers report that they have synthesized single-crystalline β-$Pb_xV_2O_5$ nanowires from vanadium oxide and lead. When exposed to an applied voltage near room temperature, the nanowires transform from insulators to metals that more readily conduct electricity. Each of these two states—insulator and metal—could stand for a 0 or 1 in the binary code that computers use to encode information, or for the "on" and "off" states that the machines use to make calculations.

"The ability to electrically switch these nanomaterials between the on and off state repeatedly and at faster speeds makes them useful for computing," said Ganapathy.

"Silicon computing technology is running up against some fundamental road blocks, including switching speeds," said Banerjee. "The voltage-induced phase transition in the material we created provides a way to make that switch at a higher speed."

As with other nanomaterials, the health and environmental impacts of the nanowires would have to be investigated before their widespread use, especially since they contain lead, Banerjee said. One intriguing characteristic of the material they synthesized is that it only exhibits valuable electrical properties in nanoform. That is because nanomaterials often have fewer defects than their bulkier counterparts.

The distinctive structure in these nanowires is crucial to their ability to switch from an insulator to a metal. Specifically, in the insulator phase, the position of the lead in the nanowires' crystalline structure induces pools of electrons to gather at designated locations. Upon applying a voltage, these pools join together, allowing electricity to flow freely through them and transforming the material into a metal.

"When materials are grown in bulk, there's a lot of defects in the crystals, and you don't see these interesting properties," said Peter Marley who is lead author. "But when you grow them on a nanoscale, you're left with a more pristine material."

Cobalt-based nanomaterial catalyzes water splitting

Efficient storage technologies are required to exploit renewable energy sources such as wind and the sun. One strategy is the conversion of these energies into fuels such as hydrogen, which can be achieved by electrolysis of water—or water splitting—into H_2 and O_2. A range of approaches have been investigated to achieve this goal. Devices based on proton-exchange membranes have proven promising, but may ultimately not be viable because they rely on electrocatalysts made from scarce and expensive noble metals, such as Pt. Robust catalysts made from abundant elements such as Co, Ni, and Mn have also been developed for the evolution of oxygen gas from water (also called the oxygen evolution reaction, OER: $2H_2O \rightarrow O_2 + 4H^+ + 4e^-$), but few catalysts have been developed for the hydrogen evolution reaction (HER: $4H^+ + 4e^- \rightarrow 2H_2$).

Addressing this problem, V. Artero and co-researchers from the French commission for Atomic Energy and Alternative Energies (CEA) centers in Grenoble and Saclay, and from the Free University Berlin, Germany, have recently developed a straightforward and practical approach to prepare a stable Co-based catalytic material for H_2 evolution.

As reported in the September issue of *Nature Materials* (DOI: 10.1038/NMAT3385; p. 802), Artero and co-researchers reduced $Co(NO_3)_2 \cdot 6H_2O$ from an aqueous phosphate buffer at a fluorine-doped tin oxide electrode. Electrolysis for 3 h at –1.0 V versus Ag/