Nanotechnology changes behavior of materials

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Thimsen

One of the reasons solar cells are not used more widely is cost—the materials used to make them most efficient are expensive. Engineers are exploring ways to print solar cells from inks, but the devices don't work as well.

Elijah Thimsen, PhD, assistant professor of energy, environmental & chemical engineering in the School of Engineering & Applied Science at Washington University in St. Louis, and a team of engineers at the University of Minnesota have developed a technique to increase the performance and electrical conductivity of thin films that make up these materials using nanotechnology. Their work was published in the Dec. 19, 2014, issue of *Nature Communications.*

Transparent conductors are thin films, which are are simply ultrathin layers of materials deposited on a surface that allow light to pass through and conduct electricity, a process in which electrons flow through a system. Thimsen and his team found by changing the structure of a thin film made of zinc oxide nanoparticles, electrons no longer flowed through the system in a conventional way, but hopped from place to place by a process called tunneling.

The team measured the electronic properties of a thin film made of zinc oxide nanoparticles before and after coating its surface with aluminum oxide. Both the zinc oxide nanoparticles and aluminum oxide are electronic insulators, so only a tiny amount of electricity flows through them. However, when these insulators were combined, the researchers got a surprising result.

"The new composite became highly conductive," Thimsen said. "The composite exhibits fundamentally different behavior than the parent compounds. We found that by controlling the structure of the material, you can control the mechanism by which electrons are transported."

Because the reason behind this is not well understood, Thimsen and the team plan to continue to work to understand the relationship between the structure of the nanoparticle film and the electron transport mechanism, he said.

"If electrons are tunneling, they're not really moving with a classical velocity and moving from one point to the next," Thimsen said. "If electrons are tunneling from one point to the next, one hypothesis is that they won't interact with strong magnetic fields. One of our long-term visions is to create a material that has high electrical conductivity but does not interact with magnetic fields."

In addition, the new composite's behavior also improved its performance, which could ultimately help to lower the cost of materials used in solar cells and other electronic devices.

"The performance is quite good, but not at the level it needs to be to be commercially viable, but it's close," Thimsen said.

More information: "High electron mobility in thin films formed via supersonic impact deposition of nanocrystals synthesized in nonthermal plasmas." *Nature Communications*, Dec. 19, 2014. DOI: 10.1038/ncomms6822

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