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Nanoparticles transmit the heat

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Researchers at the University of Illinois and University of Minnesota, both in the US, have been looking at thermal transport in polymer-coated gold nanoparticles. They found that adding a solvent that caused the polymer coating to swell led to an unexpectedly large increase in the thermal conductivity of the layer.

"Metal nanoparticles, especially gold nanoparticles, have been proposed as targeted thermal agents for use in medical therapies and drug delivery, and could greatly extend the precision of thermal effects below cellular dimensions," Zhenbin Ge of the University of Illinois told *nanotechweb.org*. "Our method provides novel and quantitative ways to study the effects of interface structure and chemistry on the nanoscale thermal transport across solid-liquid interfaces, and to establish a scientific basis for using heat dissipation from metal nanoparticles for medical therapies."

Ge and colleagues used a laser to both heat up the nanoparticles and to measure the change in optical absorption caused by heating. This indicates the cooling rate of the nanoparticles.

The particles themselves consisted of a 30 nm-diameter gold core coated with a glassy shell of polystyrene and an outer layer of cross-linked polyacrylate. Initially, the team measured the thermal conductivity of the nanoparticles in an aqueous solution.

Adding organic solvents such as tetrahydrofuran or *N, N*-dimethylformamide caused the polymer coating to swell, doubling its thermal conductivity and doubling the cooling rate of the gold core. The scientists say that the increase in conductivity of the polymer coating cannot be directly attributed either to solvent penetration into the shell or to enhanced alignment of the polystyrene backbone.

Ge and colleagues also stress that theoretical calculations of heat transport in nanoscale systems may not be reliable if based on bulk thermal properties.

"Metal nanoparticles provide a great way to probe nanoscale thermal transport, but they have certain limitations due to synthesis and stabilization difficulties. For example, it is hard to prepare hydrophobic surfaces in water in nanoparticle systems," said Ge. "We are designing a planar thin-film system, in which we can have greater flexibility and control of the surface in studies of thermal transport at the nanoscale across the solid-liquid interfaces."

The researchers reported their work in *Nano Letters*.

About the author

Liz Kalaugher is editor of *nanotechweb.org*.

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