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NEWS | JULY 09 2021

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Alane Lim

Scilight 2021, 281102 (2021)
https://doi.org/10.1063/10.0005618

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6 July 2021

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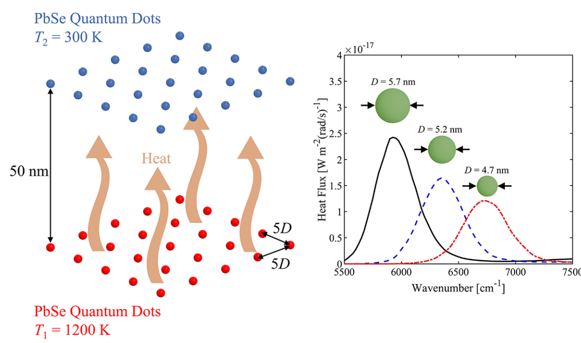
Researchers model how the sizes of quantum dots can change their radiative-heat-transfer properties.



Hot objects can warm up colder ones even if they are not touching, thanks to thermal electromagnetic waves. Near-field thermal radiation, at distances smaller than the wavelength, can greatly exceed the blackbody limitation, which suggest using radiation transfer associated with a subwavelength structure.

Many applications related to this enhanced radiative heat transfer require tuning of the frequency via the structure of emitter. Zare and Edalatpour reported about a mechanism for tuning radiative heat transfer in nanomaterials.

The mechanism relies on the size difference between hot and cold nanosized counterparts. When a nanoparticle has the size of just a few thousand atoms, called a quantum dot, it experiences quantum confinement. This drastically changes the particle's electronic structure and hence how heat is emitted and transferred from the particle.

By calculating the local density of states, the authors showed the peak frequency of radiative heat transfer between a hot and cold array of lead chalcogenide quantum dots significantly blueshifts as the quantum dots become smaller.

"Radiative heat transfer between the two arrays peaks around the bandgap energy of the quantum dots," co-author Sheila Edalatpour said. "As quantum dots get smaller, their bandgap energy increases, due to stronger quantum confinement effect, and so does the peak frequency of heat transfer."

To probe the frequency at which the optimized heat transfer occurred, the authors extracted the quantum dots' dielectric function from experimental data in the scientific literature. This function, which determines how a material exchanges radiative heat with other objects, helped the team calculate the radiative heat transfer between the two quantum-dot arrays.

The authors plan to continue their work by experimentally verifying their theoretical results.

Source: "The quantum confinement effect on the spectrum of near-field thermal radiation by quantum dots," by Saman Zare and Sheila Edalatpour, *Journal of Applied Physics* (2021). The article can be accessed at https://doi.org/10.1063/5.0049729.