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NEWS | NOVEMBER 08 2019

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Scilight 2019, 451102 (2019)
https://doi.org/10.1063/10.0000221

AIP Publishing

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4 November 2019

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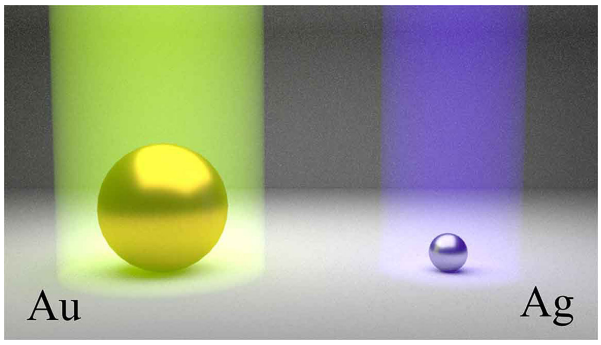
New paper explores the photo-thermal response of nanoparticles based on their size and the illumination wavelength and shows that silver nanoparticles are more efficient than gold only when smaller than 20 nm.



Metal nanoparticles, when illuminated by an external light source, can be used for heat generation at a nanoscopic level. This has a diverse range of emerging applications in photothermal imaging, photothermal therapy, and thermo-photovoltaics.

In a series of calculations, a paper by Ieng-Wai Un and Yonatan Sivan refines the current understanding on the relationship between the nanoparticle size, the illumination wavelength, and the subsequent photothermal response of the nanoparticles. The authors find that particle temperature varies with particle size. Then they identified the optimal nanoparticle size and illumination wavelength for heat generation.

Contrary to other theoretical studies based on the quasi-static approximation, the authors showed that silver nanoparticles are more efficient at heat generation than gold nanoparticles only when nanoparticle size is less than 20 nm.

“We find that when the nanoparticle size is sufficiently large, radiation damping dominates over absorption such that gold nanoparticles become more efficient nanoheating sources than silver nanoparticles,” author Un said.

The authors expect that further research will include studying the thermo-optical nonlinearity of nanoparticles under intense illumination and examining the thermo-optical responses of nanoparticle arrays.

“We can obtain the temperature rise profile of a nanoparticle array by summing properly the heat generation from all nanoparticles. In this case, one must take into account the finite penetration depth of the incident field into the nanoparticle array due to absorption by the nanoparticles. This approach allows us to identify from first principles the most relevant physical effects on the heat generation of nanoparticle arrays,” Un said.

Source: “Size-dependence of the photothermal response of a single metal nanosphere,” by Ieng-Wai Un and Yonatan Sivan, *Journal of Applied Physics* (2019). The article can be accessed at https://doi.org/10.1063/1.5123629.