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Effect of temperature on plasmonic resonances in semiconductors and metals

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Plasmonically enhanced absorption or scattering of radiation on the mesoscale forms the basis of promising applications in a wide variety of fields such as: biosensing, photothermal therapy, photocatalysis, solvothermal chemistry, energy harvesting, magnetic recording for data storage, control of radiative heat transfer and so on. In a majority of the applications based on plasmonics, the noble metals - gold (Au) and silver (Ag) - have been the materials of choice. However, it is also now widely acknowledged that these materials suffer from problems of poor thermal and chemical stability accompanied by significant dissipative losses under high-temperature conditions. These issues have thus prompted a quest for materials with better thermoplasmonic properties. In this regard, semiconductor particles have lately attracted a lot of attention because they exhibit low ohmic losses, are thermochemically more stable, and exhibit highly tunable plasmonic resonances through bandgap engineering, control over dopant concentration and dielectric environment. Here, we will present results from our recent work on the multiscale modeling of plasmonically enhanced control of heat radiation using semiconductor inclusions [1, 2]. Furthermore, a comparison of the size-dependent thermoplasmonic behavior of indirect and direct bandgap semiconductor particles of undoped silicon (Si) and gallium arsenide (GaAs), respectively, with the metallic (Au) particles that are characterized by a complete absence of the bandgap will also be presented [3].

References

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