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Imaging and Temperature Sensing using Submillimeter Radiation

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In recent years, nanomaterials have garnered significant attention in the effort to develop novel applications and technologies, or for the improvement of already existing ones. In particular, a strong emphasis has been placed on nanoparticle-based probes than can be used in imaging and therapeutics. Of particular interest are metal nanoparticles such as silver, platinum and gold, which following resonant excitation with light, show a surface plasmon resonance effect. An interesting by-product of this effect is the transfer of energy to the environment in the form of heat. This typically increases the temperature of a system and finds interesting applications particularly in photothermal therapy. We have used gold nanoparticles as "contrast agents"in combination with terahertz radiation to develop a contact-free approach for heating, temperature sensing and imaging. More specifically, we exploit the change in the refractive index of water, induced by localized NIR heating of plasmonic nanostructures. The latter, namely gold nanorods, were prepared using a conventional bottom up seed-mediated technique. We observe a linear relationship correlating change in the reflected terahertz amplitude and area under the curve as a function of increasing temperature. This was translated to a thermometric relationship allowing for temperature sensing following an induced heat stimulus. We extended our results to the porcine skin model system in order to mimic the photothermal effect and demonstrated the capacity to sense the temperature and map its distribution in the localized injection site, following controlled NIR plasmonic heating. As a result, we have developed a terahertz biological thermometer.

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