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Analysis of temperature distribution around metallic nanoparticles for photoacoustics biosensing

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Photoacoustic sensing relies on the conversion of optical energy to acoustic energy via the thermoelastic effect. The efficiency of this conversion is given by the Gruneisen coefficient that is considered in usual photoacoustic applications to be a function of the medium equilibrium temperature. However, we show in this work both theoretically and experimentally, that this assumption is not always valid and in particular when metallic nanoparticles are used. Indeed, in this case, in addition to the medium equilibrium temperature, the transient and localised temperature rise in the vicinity of the absorber during the illumination pulse has to be taken into account. Therefore, the photoacoustic signal dependences on the fluence and on the medium equilibrium temperature are complex non-linear functions of the absorbers properties and the illuminations conditions. It is shown that higher the photoacoustic signal frequencies (around a few tens of MHz) the more important these non-linear effects. Improved accuracy of photoacoustic temperature monitoring using metallic nanoparticles contrast agents, non-linear photoacoustic imaging at high frequencies, and photoacoustic temperature sensing at a nanometric scale are the most relevant applications of this work for biosensing.

Biography

Olivier Simandoux received a Master degree in Science and Engineering from Institut d'Optique, Paris, France and ESPCI ParisTech, Paris, France, as well as a Master degree in Physical Acoustics from Université Paris Diderot, Paris, France, in 2011. He is currently working towards a PhD degree at Insitut Langevin at ESPCI ParisTech-CNRS where he is working on photoacoustic microscopy and cancerous tumors imaging.

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