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Lock-in thermography for the analysis of plasmonic nanomaterials

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Plasmonic nanomaterials are nowadays frequently employed in research and industrial applications. These materials are well-known for their ability to efficiently convert electromagnetic energy into heat. This characteristic property renders them as promising candidates in photothermal cancer therapies, biochemical sensing and spectroscopy. Hence, reliable tools to analyse their plasmonic heating are of great interest.

Lock-in thermography is an interesting candidate for such a purpose, as it is highly sensitive towards temperature changes down to the millikelvin range. Furthermore, it stands out due to its straightforward measurement approach, rapid detection system, and its non-destructive as well as non-intrusive nature. Hence, the aim of this thesis is to explore the potential light-stimulated lock-in thermography for the detection and characterisation of plasmonic nanomaterials. In that context, the principle measurement approach, experimental setup, potential applications as well as advantages and limitations in comparison to related techniques are highlighted in detail.

Different studies are presented in this thesis, which discuss and verify the applicability of the method for various scientific settings. In a principal investigation the sensitivity of the techniques is established, along with its detection limits. Additionally, it is demonstrated how lock-in thermography is capable of resolving differences in plasmonic nanoparticle aggregation state. Further studies focus on the detection of plasmonic gold nanoparticles in complex cellular environments, and discuss the dissolution of silver nanoparticles under physiological conditions. Finally, an investigation on magnetic nanoparticle heating by using lock-in thermography highlights the method's flexibility and adaptability for different stimuli-responsive nanoparticle systems. A cost-efficient lock-in thermography measurement setup is proposed, which could help to facilitate the translation from a research-based measurement device to a complementary tool for industrial applications.

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