Active thermography for the analysis of graphene

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A large variety of methods exists to analyse mostly inorganic engineered nanoparticles (NPs) in dispersions, as thin films or embedded (e.g. in nanocomposites). However, many standard analyses (e.g. chemical analysis) fail when it comes to carbon-based nanomaterials and the analysis often requires complicated sample preparation (e.g. microtome cutting) or labelling. Methods used to detect and quantify carbon-based nanomaterials or analyse their size, size distribution, and colloidal state in analytically complex environments (e.g. cell culture media, serum etc) like dark-field hyperspectral imaging, electron microscopy or dynamic light scattering require complex and time-consuming sample preparation, are lacking spatial information and only analyse a small portion of the sample. Additionally, the quantification of carbon nanomaterials is even more challenging and methods for their quantification are simply missing.
Carbon nanomaterials have the ability to produce heat upon external stimulation by absorbing and scattering light [1], [2].
In this talk I will present a new technique based on lock-in-thermography (LIT) to measure and quantify the heat produced by carbon nanomaterials upon light stimulation. This heat can be recorded with an infrared camera and is processed by a specially developed LIT algorithm to yield 2D-images for analysing carbon nanomaterials. The advantage of this set-up is the fast and accurate analysis of carbon nanomaterials in a variety of matrices, without requiring complicated sample preparation. Additionally, the method can be used for semi-quantitative analysis [3], [4].

References

[1] K Jiang, DA Smith, A Pinchuk, J. Phys. Chem. C, 55 (2013) 27073–27080
[2] D Jaque, L Martínez Maestro et. al, Nanoscale, 6 (2016) 9494-9530
[3] L Steinmetz, J Bourquin, et. al, Nanoscale, 12 (2020) 17362
[4] L Steinmetz, C Geers et. al, J. Phys. Chem. C, 10 (2021) 5890-5896

Figures

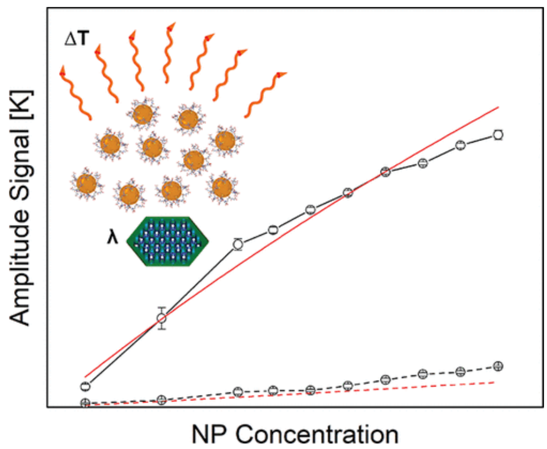

Figure 1: Nanoparticle concentration vs. averaged heating signal [4].