Lock-in thermography to investigate nanomaterial-cell association trends

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The characterization of nanomaterials (NMs) in complex environments are prominent research interests in nanotechnology. Applied methods must be capable of analyzing nanomaterials with various sizes, shapes and chemical compositions. When those NMs are e.g. exposed to a cellular environment they will likely be associated and uptaken by cells. Common techniques to investigate NM-cell interactions include e.g. inductively coupled plasma mass spectrometry (ICP-MS), electron microscopy (EM) or laser scanning microscopy (LSM). However, all these methods have their limitations, e.g. time-consuming sample preparation and measurements or sample destruction [1]. Therefore, new complementary approaches are being developed. Lock-in thermography (LIT) is a sensitive infrared imaging technique, which is commonly used to test composites and electronic components [2]. The method allows analysis of stimuli-responsive samples by applying a trigger to excite NPs, resulting in the generation of heat [3]. Sample preparation is straight-forward and solid as well as liquid samples can be investigated in a non-destructive and non-intrusive way. We used LIT to stimulate plasmonic gold nanoparticles (AuNPs) and multiwalled carbon nanotubes (MWCNTs), which we exposed to different cell types for 24 hours. Homogeneous light of a specific wavelength was applied to excite these nanomaterials. The result is a 2D heat map, which allows quantifying the produced heat with respect to the applied light intensity. Hence, we gain insights in the degree of NM-cell association over the course of 24 hours by measuring at different time points.

References

[1] Mourdikoudis et al., *Nanoscale* 2018, 10, 12871.
[2] Huth et al., *Solid State Phenom.* 2002, 82–84, 741.
[3] Monnier et al., *Nanoscale* 2016, 8, 13321.

Figures

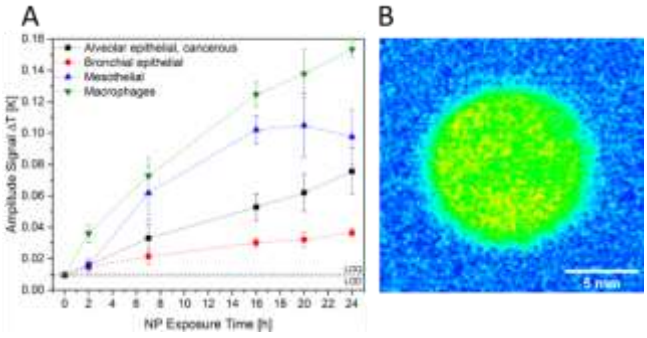

Figure 1. NM-cell association trends for different cell types over 24 hours (A) and 2D heat map obtained by lock-in thermography measurements (B). Feedback on the NM-cell association rate can by drawn by analyzing the characteristic heating behavior of NMs at different exposure time points. High temperatures are depicted in red (B).