Active Thermal Imaging for Carbon and Metal thin films

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A large variety of methods exists to analyze inorganic engineered (nano)materials in thin films. Many standard analyses can offer information on the film homogeneity and film thickness. However, techniques such as electron microscopies and atomic force microscopy are often not statistically significant because they allow investigating only a small portion of the sample, and often require a complex sample preparation (e.g., TEM lamella preparation with a focused ion beam) and highly specialized users. Moreover, measurements become unreliable when the film thickness is below tens of nm (e.g., interferometry) and above hundreds of µm. [1, 2] Ellipsometry can investigate very thin films, but requires complex models to interpret the results, while other commercially available spectroscopic instruments fail to investigate materials made of light elements such as carbon.[3]
Here, we present a new non-destructive technique based on lock-in-thermography (LIT) to determine the thickness and homogeneity of carbon and metal thin films. LIT measures and quantifies the heat produced by carbon-based nanomaterials exposed to amplitude-modulated light stimulation.[4, 5] This heat can be recorded with an infrared camera and is then processed by a specially developed LIT algorithm to yield 2D images, which can be used to analyzing the uniformity of samples.[6, 7] The presented model allows the quantitative determination of the film thickness. The great advantage of our novel approach is the fast, easy and accurate analysis of carbon thin films, without requiring complicated sample preparation. The approach was also validated with gold and platinum thin films of different thicknesses.

References

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Figures

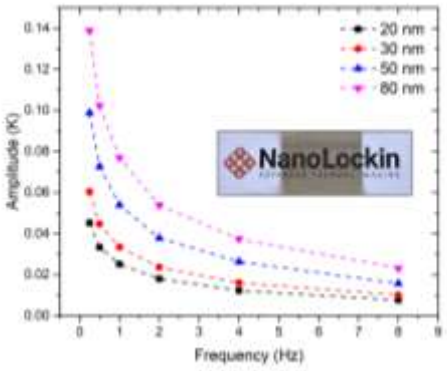

Figure 1: Graph of the measured temperature amplitude of different carbon deposited films as a function of the modulation frequency of the thermal stimulation. The inset shows a picture of a typical carbon films investigated in this work.