

# Time-resolved high-sensitive thermal imaging system for the study of transient thermal phenoma

Antoine Federici<sup>1</sup>, Guillaume Baffou<sup>2</sup>, Serge Monneret<sup>2</sup> and Benoit Wattellier<sup>1</sup>

<sup>1</sup>Phasics S.A., Espace technologique de Saint Aubin, Route de l'Orme des Merisiers, 91190 Saint Aubin, France

<sup>2</sup> Aix Marseille Univ, CNRS, Centrale Marseille, Institut Fresnel, Marseille, France

E-mail: [contact@phasics.fr](mailto:contact@phasics.fr)

Thermal Imaging using Quadriwave Shearing Interferometry (TIQSI) at the microscopic level was proved to be possible by quantitatively measuring the transmitted wide-field phase signal. This approach, introduced by G. Baffou in collaboration with PHASICS SA [1], is able to measure temperature variation fields from thermal-induced refractive index changes of the medium surrounding heat sources. These heat sources are generated by a laser wave source illuminating plasmonic nanoparticles. Heat maps and temperature fields are measured in parallel thanks to a SID4 camera, developed by PHASICS. The quantitative phase signal is deconvolved to obtain the temperature variation and heat map values. With this technology, high-resolution of 1°C has been achieved.

In this paper we introduce a new TIQSI modality based on synchronous detection aiming at measuring the thermodynamics and thermal conductivity properties of a sample. It consists in triggering the camera acquisition with respect to the heating laser pulse fronts and study the sample response to transient thermal phenomena.

Another benefit of this new TIQSI modality is signal-to-noise (SNR) enhancement of the temperature images. Depending on the modulation frequency of the laser source, locked-in with the SID4 camera, low-frequency noise is filtered out which leads to noise reduction. This enables the detection of small nanobeads at low laser fluence careful to biological samples. We will present 10nm-diameter gold nanobeads detection with a temperature resolution of 0.1°C and high SNR value.

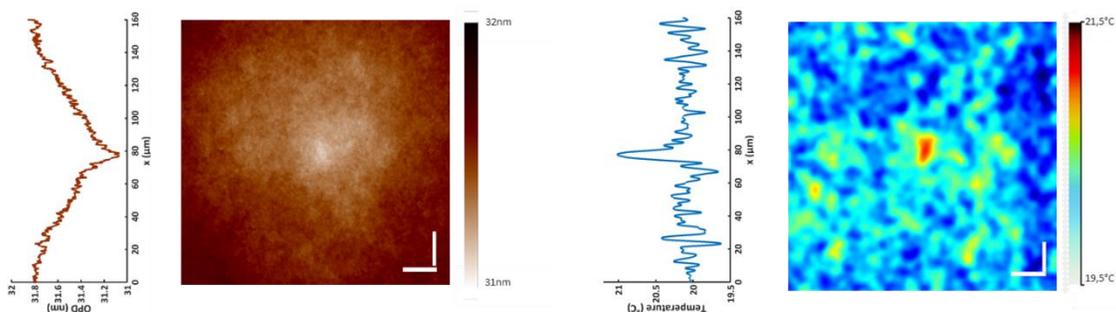


Figure: Phase and temperature images and associated signal profiles of an illuminated 10nm-gold nanobeads for 1000 averaged images acquired with a modulated TIQSI system. Bar scales = 20μm

[1] Baffou, G., Bon, P., Savatier, J., Polleux, J., Zhu, M., Merlin, M., ... & Monneret, S. (2012). Thermal imaging of nanostructures by quantitative optical phase analysis. *ACS nano*, 6(3), 2452-2458.