Thermal Characterization of Candidate Materials for SThM Calibration

Bruno Hay [C, S]
Centre for Scientific and Industrial Metrology, LNE, Trappes, France
bruno.hay@lne.fr

Severine Gomes
INSA de Lyon, CETHIL, UMR5008, Université de Lyon, CNRS, Villeurbanne, France

Alexandre Allard and Liana Ramiandrisoa
Centre for Scientific and Industrial Metrology, LNE, Trappes, France

Ali Assy and David Renahy
INSA de Lyon, CETHIL, UMR5008, Université de Lyon, CNRS, Villeurbanne, France

Guillaume Davee
Centre for Scientific and Industrial Metrology, LNE, Trappes, France

Scanning Thermal Microscopy (SThM) is a key promising technique for thermal measurements at nanoscale, but it remains highly non-quantitative in normal use. However, some studies reported to date showed a possibility of quantitative thermal measurements with a submicrometric spatial resolution by performing the SThM calibration with bulk materials of known thermal conductivity. The thermal conductivity values associated to these bulk materials usually come from literature, and can be therefore different depending on the bibliographic sources. It is consequently not possible to ensure the accuracy and the traceability to the international system of units of these nanoscale measurements, in particular due to the lack of suitable reference materials. To meet these needs, one task of the European project Quantiheat "Quantitative scanning probe microscopy techniques for heat transfer management in nanomaterials and nanodevices" is devoted to the thermal characterization of potential candidate materials for SThM calibration. The QUANTIHEAT project aims at solving the problems of thermal metrology at the nano-scale, especially by delivering materials and protocols for the calibration of SThM devices, and by developing numerical modelling tools for increasing the understanding of heat transfer in SThM measurements. The thermal conductivity of the bulk calibration materials are determined by LNE at 23 °C using an indirect method which is based on the measurements of the thermal diffusivity (by laser flash method), the specific heat (by differential scanning calorimetry) and the density (Archimedean method) of the studied materials. After a specification of the criteria defined to choose the more suitable materials for SThM calibration, this paper presents the materials selected, the facilities and methods used for their thermal characterization, as well as the thermal conductivity values obtained and their associated uncertainties.

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