Uncertainty on Thermal Conductivity Measurements Performed at LNE by Scanning Thermal Microscopy

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Restricted in the past to comparative measurements, Scanning Thermal Microscopy (SThM) is presented today as candidate technique for performing quantitative thermal measurements at nanoscale. Some recent projects showed the possibility of measuring thermal conductivity with a submicrometric spatial resolution by performing the calibration of SThM devices using bulk materials of known thermal properties and relevant calibration protocols. This could enable to have a better understanding of heat transfers at these scales, especially in industrial fields concerned by the thermal characterization of thin films, nano-objects, or active integrated devices. Despite an abundant literature on experimental results, no uncertainty assessment associated with the quantitative measurements of thermal conductivity by SThM has been done so far. This metrological work is indeed quite complex because of the use of an inversion model for the determination of the thermal conductivity of the tested samples from a direct measurand (chosen here as the variation DR of the probe electrical resistance when it is in contact with the sample and when it is out of contact). As a national metrology institute, the *Laboratoire National de Metrologie et d'Essais* has performed for the first time a full evaluation of this measurement uncertainty in the framework of the European project QUANTIHEAT. This paper gives a detailed description of the approach applied to estimate these uncertainties for measurements performed using a SThM equipped with resistive Pd-probes. Given the complexity of the measurement model, a Monte Carlo method was used to perform the propagation of distributions according to the principles of the ISO/BIPM "Supplement 1 to the Guide to the expression of uncertainty in measurement". The relative standard uncertainty (k=1) on thermal conductivity measurement is estimated to be around 10 % in the most favorable configurations corresponding to low conductive materials for which the sensitivity of the measurement method is the highest.