Progress Report on Absorbed Dose Calorimetry at the BIPM

CCRI(I) May 2007

Susanne Picard, David Burns and Philippe Roger

Bureau International des Poids et Mesures

With a view to implementing absorbed dose calorimetry at the BIPM, the project to realize a graphite calorimeter has been developed, and since 2004 several sub-projects have been undertaken towards this goal.

A simplified calorimeter configuration has been chosen that does not involve electrical heating. Rather, it is necessary to know the specific heat capacity of the graphite. This has been measured by applying a straightforward method, reported in [1].

However, it was discovered that the influence from systematic uncertainties could be significant. This triggered the application of a second method to measure the specific heat capacity of graphite, based on a macroscopic differential method that eliminates some of the systematic uncertainties. The results obtained by the differential method are in agreement with those obtained by the direct method.

To reduce the uncertainties, the specific heat capacity has been measured for the epoxy resin used in the calorimeter, and for the cyanoacrylate used in the specific heat capacity arrangement.

In order to test the experimental method applied, the specific heat capacity has also been measured for synthetic sapphire, Al_2O_3, a reference material for specific heat capacity. The results obtained for the BIPM sample are in accordance with former results reported by Archer [2] and by Grønvold and collaborators [3]. This methodology also enabled testing of the empirical temperature analysis model, developed to simulate the temperature behaviour of the measured sample [4].

The specific heat capacity of a graphite sample has subsequently been measured with a relative standard uncertainty of 8 parts in 10^4 [5]. This means that the uncertainty of the specific heat capacity is not the limiting factor in the determination of absorbed dose to water with a relative uncertainty of some parts in 10^3.

The graphite calorimeter is currently being fabricated. In parallel, measurement of the specific heat capacity using an ensemble of graphite samples that have been taken from around the calorimeter core is in progress.

[1] Picard S, Burns D T and Roger P 2006 Measurement of the Specific Heat Capacity of Graphite *Rapport BIPM-2006/01* (Sèvres: Bureau International des Poids et Mesures) 31p.

[2] Archer D G Thermodynamic properties of synthetic sapphire (α-Al_2O_3), standard reference material 720 and the effect of temperature-scale differences on thermodynamic properties 1993 *J. Phys. Chem. Ref. Data* **22** 1441-53

[3] Stølen S, Glöckner R and Grønvold F 1996 Heat capacity of the reference material synthetic sapphire (α-Al_2O_3) at temperatures from 298.15 K to 1000 K by adiabatic calorimetry. Increased accuracy and precision through improved instrumentation and computer control *J. Chem. Thermodynamics* **28** 1263-81

[4] Picard S, Burns D T and Roger P 2007 Measurement of the Specific Heat Capacity of Synthetic Sapphire (α-Al_2O_3) from 293 K to 302 K, *to be submitted.*

[5] Picard S, Burns D T and Roger P 2007 Determination of the Specific Heat Capacity of a Graphite Sample Using Absolute and Differential Methods, *to be submitted.*