National Institute of Standards & Technology

Certificate

Standard Reference Material® 764a

Magnetic Susceptibility Standard – Platinum Cylinder

This Standard Reference Material (SRM) is intended for use in the calibration of magnetometers (such as vibrating sample magnetometers) used in the measurement of the magnetic properties of materials. SRM 764a consists of a platinum (Pt) cylinder with a nominal diameter of 3 mm, a nominal length of 3.42 mm, and a nominal mass of 620 mg. SRM 764a lot was produced by slicing a pure (99.99 %) platinum rod into 3.42 mm long pieces.

Certified Values and Uncertainty: The certified value for the specific susceptibility, χ, at 297 K is:

$$\chi = 1.268 \times 10^{-8}\ \mathrm{m^3/kg} \pm 0.004 \times 10^{-8}\ \mathrm{m^3/kg}\ (1.009 \times 10^{-6}\ \mathrm{emu/g{\bullet}Oe} \pm 0.003 \times 10^{-6}\ \mathrm{emu/g{\bullet}Oe}) \quad (1)$$

The uncertainty in the certified value is calculated as $U = ku_c$, where $k = 2$ is the coverage factor for a 95 % level of confidence and u_c is the combined standard uncertainty calculated according to the NIST and ISO Guides [1–3].

Corrections for temperature can be made using equation 2:

$$\chi = (1.268 \times 10^{-8})\,[1 - 0.00081\,(T - 297)] \quad (2)$$

where χ is the specific susceptibility in m^3/kg and T is the temperature in kelvins. Using this correction, the stated uncertainty remains the same between 293 K and 303 K, providing the temperature is accurate to ± 0.5 K. For temperatures between 250 K and 293 K and between 303 K and 310 K, the uncertainties are approximately doubled. No correction for applied field is necessary for fields between 0 kA/m and 800 kA/m (≈10 kOe). To determine the magnetic moment, m, in Am^2 at any field, the user should determine the mass of the cylinder, W, in kg and multiply this value by the value of the specific susceptibility in m^3/kg and by the field value, H, in A/m according to equations (3) and (4) below. The mass value, W, of each sample at the time of its packaging is provided with the SRM unit (see "Note on Mass Value").

$$m\,(\mathrm{Am^2}) = \chi\,(\mathrm{m^3/kg}) \times W\,(\mathrm{kg}) \times H\,(\mathrm{A/m}) \quad (3)$$

$$= \chi\,(\mathrm{m^3/kg}) \times W\,(\mathrm{kg}) \times H\,(\mathrm{Oe}) / (4\pi \times 10^{-3}) \quad (4)$$

Expiration of Certification: The certification of this SRM is valid indefinitely within the measurement uncertainties specified provided the SRM is used in accordance with the instructions in this certificate. If damage or discoloration are visible, discard the SRM.

Certification of this SRM was performed by R.D. Shull, L.J. Swartzendruber, D.J. Twisselmann, and R.D. McMichael of the NIST Metallurgy Division.

Technical advice and assistance were provided by F. Johnson, D. Mathews, L.C. Smith, G.E. Hicho, A.J. Shapiro, and R.V. Drew of the NIST Metallurgy Division.

Statistical analysis and measurement advice were provided by S.D. Leigh of the NIST Statistical Engineering Division.

Frank W. Gayle, Chief
Metallurgy Division

Gaithersburg, MD 20899
Certificate Issue Date: 13 November 2006

Robert L. Watters, Jr., Chief
Measurement Service Division

The support aspects involved in the issuance of this SRM were coordinated through the NIST Measurement Services Division.

The platinum cylinders were cut from a pure (99.99 %) Pt rod obtained from Electronic Space Products International, Inc.[1], (Ashland, Oregon).

Measurement Technique: The magnetic moment was determined by a sampling technique using an absolute magnetometer developed at NIST based on the Faraday method. The magnetometer was calibrated using three different methods to determine the value of the field gradient.

Storage and Handling: When not in use, store SRM 764a in the packaging provided, or in a manner that provides equivalent or better protection against loss or damage. The cylinder should be carefully handled to avoid scratching, chipping, or the attachment of magnetic dust or particles from the environment. The use of plastic or other nonmagnetic tweezers with smooth surfaces and a gentle grip should be satisfactory. **DO NOT** expose the SRM to corrosive chemicals or temperatures above 373 K (100 ºC).

Maintenance of SRM Value Assignment: NIST will monitor this SRM over the period of its value assignment. If substantive technical changes occur that affect the value assignment before the expiration of this certificate, NIST will notify the purchaser. Registration (see attached sheet) will facilitate notification.

NOTE ON MASS VALUES

NIST does not generally certify the mass of magnetic materials. Mass values for these SRMs were determined in an analytical balance calibrated using standards traceable to NIST. The value given has an expanded uncertainty of $\pm$ 0.06 mg (with a coverage factor of 2).

NOTE ON UNITS

One oersted (Oe) corresponds to (1000/4π) A/m. For additional discussion on units of measure, refer to references 4 and 5.

REFERENCES

[1] ISO; *Guide to the Expression of Uncertainty in Measurement*; ISBN 92-67-10188-9, 1st ed., International Organization for Standardization: Geneva, Switzerland (1993); see also Taylor, B.N.; Kuyatt, C.E.; *Guidelines for Evaluating and Expressing the Uncertainty of NIST Measurement Results*; NIST Technical Note 1297, U.S. Government Printing Office: Washington, DC (1994); available at http://physics.nist.gov/Pubs/.

[2] *U.S. Guide to the Expression of Uncertainty in Measurement*; ANSI/NCSL Z540-2-1997, National Conference of Standards Laboratories: Boulder, CO (1997/1998).

[3] Ruhkin, AL.; Vangel, M.G.; *Estimation of a Common Mean and Weighted Means Statistics*; J. Am. Sta. Assoc., Vol. 93, No. 441, pp. 303–308 (1998).

[4] Bennett, L.H.; Page, C.H.; Swartzendruber, L.J.; *Comments on Units in Magnetism*; J. Res. Natl. Bur. Std., Vol. 83(1), p. 9 (1978).

[5] Taylor, B.N.; Guide *for the Use of the International System of Units (SI)*; NIST Special Publication 811; U.S. Government Printing Office: Washington, DC (1995).

Users of this SRM should ensure that the certificate in their possession is current. This can be accomplished by contacting the SRM Program at: telephone (301) 975-6776; fax (301) 926-4751; e-mail srminfo@nist.gov; or via the Internet at http://www.nist.gov/srm.

[1]Certain commercial organizations, services, equipment, or materials are identified in this certificate to adequately specify the experimental procedure. Such identification does not imply recommendation or endorsement by National Institute of Standards and Technology nor does it imply that the organizations, services, materials, or equipment identified are necessarily the best available for the purpose.