National Institute of Standards & Technology

Certificate of Analysis

Standard Reference Material® 361

AISI 4340 Steel

This Standard Reference Material (SRM) is intended primarily for use in chemical methods of analysis. SRM 361 is in the form of chips sized between 0.5 mm and 1.18 mm sieve openings (35 mesh and 16 mesh).

The certified values for 27 elements are listed in Table 1; information values for 13 additional elements are listed in Table 2. For all elements, values are reported as mass fractions [1]. The uncertainties for all elements, with the exception of boron, reflect the guidance given in NBS Monograph 148 [2]. The uncertainty for boron is assessed according to the ISO Guide [3].

Table 1. Certified Values for SRM 361

Element	Composition mass fraction (in %)			Element	Composition mass fraction (in %)		
Aluminum (total)	0.021	±	0.005	Neodymium	0.00075	±	0.00005
Antimony	0.0042	±	0.0001	Nickel	2.00	±	0.01
Arsenic	0.017	±	0.001	Niobium	0.022	±	0.001
Calcium	0.00010	±	0.00005	Phosphorus	0.014	±	0.001
Carbon	0.383	±	0.001	Silicon	0.222	±	0.001
Cerium	0.0040	±	0.0001	Silver	0.0004	±	0.0001
Chromium	0.694	±	0.005	Sulfur	0.0143	±	0.0003
Cobalt	0.032	±	0.001	Tantalum	0.020	±	0.001
Copper	0.042	±	0.001	Tin	0.010	±	0.001
Lead	0.000025	±	0.000005	Titanium	0.020	±	0.001
Magnesium	0.00026	±	0.00005	Tungsten	0.017	±	0.001
Manganese	0.66	±	0.01	Vanadium	0.011	±	0.001
Molybdenum	0.19	±	0.01	Zirconium	0.009	±	0.001
Boron	4.78 mg/kg	±	0.15 mg/kg				

Certified Values and Uncertainties: The certified values for boron and sulfur were determined by thermal prompt gamma activation analysis and isotope dilution spark source mass spectrometry at NIST, respectively. The boron value was confirmed using isotope dilution inductively coupled plasma mass spectrometry and inductively coupled plasma optical emissions spectrometry by Coedo et al. [4], and the sulfur value was confirmed using isotope dilution mass spectrometry data provided by the Japan Atomic Energy Research Institute (JAERI). The expanded uncertainty for boron is calculated as $U = ku_c$, where u_c is intended to represent, at the level of one standard deviation, the combined effect of uncertainty components associated with the measurements and with element inhomogeneity. The coverage factor, $k = 2$, is determined from the Student's t-distribution with 5.9 degrees of freedom and corresponds to an approximate 95 % confidence interval. The other elements were measured at NIST and the cooperating laboratories using a variety of chemical methods. The certified values and uncertainties for these elements are the present best estimates of the true values based on the results of the cooperative analytical program.

Expiration of Certification: The certification of SRM 361 is valid, within the measurement uncertainties specified, until **30 April 2016**. This certification is nullified if the SRM is damaged, contaminated, or modified in any way other than its intended use.

The technical and support aspects involved in the original preparation, certification, and issuance of this SRM were coordinated through the NIST Standard Reference Materials Program by R.E. Michaelis. Revision of this certificate was coordinated through the NIST Standard Reference Materials Program by C.R. Beauchamp.

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Table 2. Information Values for SRM 361

Element	Composition mass fraction (in %)	Element	Composition mass fraction (in %)
Bismuth	0.0004	Oxygen	0.0009
Gold	< 0.00005	Praseodymium	0.0003
Hafnium	0.0002	Selenium	0.004
Hydrogen	< 0.0005	Strontium	< 0.0005[a]
Iron (by difference)	95.6	Tellurium	0.0006
Lanthanum	0.001	Zinc	0.0001
Nitrogen	0.0037		

[a] Element "not detected"

The overall direction and coordination of the original technical measurements leading to certification were performed under the direction of O. Menis, B.F. Scribner, J.I. Shultz, and J.L. Weber, Jr., of the NIST Analytical Chemistry Division. Coordination of the boron measurements leading to certification was performed by R.R. Greenberg and R.M. Lindstrom of the NIST Analytical Chemistry Division.

The original chemical analyses were performed by R. Alvarez, D.A. Becker, E.L. Garner, T.E. Gills, E.J. Maienthal, C.W. Mueller, P.J. Paulsen, K.M. Sappenfield, B.A. Thompson, S.A. Wicks, and J. Wing of the NIST Analytical Chemistry Division. Prompt gamma neutron activation analyses were performed by R.M. Lindstrom of the NIST Analytical Chemistry Division.

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PREPARATION, TESTING, AND ANALYSIS

The material for this standard was vacuum melted and cast, under contract, by the Carpenter Technology Corporation, Reading, PA, to provide material of the highest possible homogeneity. The contract was made possible by a grant from the American Iron and Steel Institute (AISI). Following acceptance of the material, selected portions of the ingots were extensively tested for homogeneity by D.M. Bouchette, S.D. Rasberry, and J.L. Weber, Jr., of the NIST Analytical Chemistry Division. Certification analyses were made on composite samples. However, for certain elements and based on previous experience, only one composite sample was analyzed with the results applied to the other forms of the material.

REFERENCES

[1] Taylor, B.N., "Guide for the Use of the International System of Units (SI)," NIST Special Publication 811, 1995 Ed., (April 1995).

[2] Cali, J.P. et al, "The Role of Standard Reference Materials in Measurement Systems," NBS Monograph 148, p. 21, (1975).

[3] *Guide to the Expression of Uncertainty of Measurement*, ISBN 92-67-10188-9, 1st Ed., ISO, Geneva, Switzerland, (1993); see also Taylor, B.N. and 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/.

[4] Coedo, A.G., Dorado, T., Fernandez, B.J., and Alguacil, F.J.; "Isotope Dilution Analysis for Flow Injection ICPMS Determination of Microgram per Gram Levels of Boron in Iron and Steel after Matrix Removal," Analytical Chemistry; **68**, pp. 991-996, (1996).

Certificate Revision History: 29 May 2001 (This revision reflects the addition of a new boron value and editorial changes); 20 May 1996 (This revision reflects the removal of the boron value and editorial changes); 24 February 1981 (This revision reflects a change in the sulfur value); 5 June 1979 (This revision reflects changes in the boron, cobalt, and sulfur values); 8 January 1976 (This revision reflects the addition of nine certified elements); 26 July 1970 (Originally issued as a provisional certificate).

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 http://www.nist.gov/srm.