



National Institute of Standards & Technology

Certificate of Analysis

Standard Reference Material[®] 1171

Stainless Steel (Cr 17-Ni 11-Ti 0.3) (AISI 321)

This Standard Reference Material (SRM) is intended primarily for use in optical emission and X-ray fluorescence spectrometric methods of analysis. A unit of SRM 1171 is an annealed solid disk approximately 31 mm × 19 mm.

Certified Values: Certified values for constituents in SRM 1171 are provided in Table 1. All values are reported as mass fractions [1]. The uncertainty listed with the value is an expanded uncertainty, $U = ku_c$, based on a 95 % confidence level [2] and is calculated according to the method in the ISO/JCGM Guide [3]. A NIST certified value is a value for which NIST has the highest confidence in its accuracy in that all known or suspected sources of bias have been investigated or taken into account [4]. A certified value is the present best estimate of the “true” value based on the results of analyses performed at NIST and collaborating laboratories. Test methods used to determine these elements are identified in the appendix and the accompanying key.

Reference Values: A reference value for cobalt is listed in Table 2. Reference values are non-certified values that are the present best estimates of the true values; however, the values do not meet the NIST criteria for certification and are provided with associated uncertainties that may not include all components of uncertainty [4]. The uncertainty listed with the value is an expanded uncertainty based on a 95 % confidence level [4] and is calculated according to the method in the ISO/JCGM Guide [3].

Information Values: Information values are provided for additional constituents in Table 3. An information value is considered to be a value that will be of interest to the SRM user, but insufficient information is available to assess the uncertainty associated with the value. They are intended to provide additional information on the matrix.

Expiration of Certification: The certification of **SRM 1171** is valid indefinitely, within the measurement uncertainty specified, provided the SRM is handled and stored in accordance with the instructions given in this certificate (see “Instructions for Use”). Periodic recertification of this SRM is not required. The certification is nullified if the SRM is damaged, contaminated, or otherwise modified.

Maintenance of SRM Certification: NIST will monitor this SRM over the period of its certification. If substantive technical changes occur that affect the certification, NIST will notify the purchaser. Registration (see attached sheet or register online) will facilitate notification.

Overall direction and coordination of the technical measurements leading to the certification were performed by O. Menis and J.I. Shultz. Homogeneity testing was performed S.D. Rasberry, J. McKay, and B.F. Scribner of NIST.

Review and revision of value assignments was performed by J.R. Sieber and W.R. Kelly of the NIST Chemical Sciences Division.

Statistical consultation for this SRM was provided by D.D. Leber of the NIST Statistical Engineering Division.

Support aspects involved in the issuance of this SRM were coordinated through the NIST Office of Reference Materials.

Carlos A. Gonzalez, Chief
Chemical Sciences Division

Gaithersburg, MD 20899
Certificate Issue Date: 25 June 2014
Certificate Revision History on Page 3

Robert. L Watters, Jr., Director
Office of Reference Materials

Analyses for certification were performed by the following: NIST: R.K. Bell, T.A. Rush, T.C. Rains, and S.A. Wicks; Armco Steel Corporation, Baltimore, MD: R.L. LeRoy and L.V. Beauchamp; and Carpenter Technology Corporation, Research and Development Center, Reading, PA: J.O. Strauss.

INSTRUCTIONS FOR USE

The test surface is the side opposite to the surface labeled with the SRM number and the diamond-shaped NBS logo. The entire thickness of the unit is certified. Each packaged disk has been prepared by finishing the test surface using a milling machine. The user must determine the correct surface preparation procedure for each analytical technique. The user is cautioned to use care when either resurfacing the disk or performing additional polishing as these processes may contaminate the surface. The material should be stored in its original container in a cool, dry location. This material was tested using both solid disks and chips prepared from the same material. The certified values are considered to be representative of the overall average composition of the material.

PREPARATION AND, ANALYSIS⁽¹⁾

The material for this standard was prepared at the Duquesne Works, U.S. Steel Corporation, Pittsburgh, PA. A portion from a selected slab was cropped at the top and bottom, and the center longitudinal 1/3 of the remaining section was cut out and discarded. The remaining cores were processed to the final size by hot rolling, annealing, and centerless grinding by Carpenter Technology Corporation, Reading, PA.

Homogeneity testing was performed using X-ray fluorescence spectrometry. Certification analyses were performed using the methods provided in the appendix.

Table 1. Certified Values for SRM 1171 Stainless Steel (Cr 17-Ni 11-Ti 0.3)

| Constituent | Mass Fraction (%) | Expanded Uncertainty (Mass Fraction, %) | Coverage Factor, <i>k</i> |
|-------------|-------------------|---|---------------------------|
| C | 0.067 | 0.010 | 12.7 |
| Cr | 17.50 | 0.15 | 3.2 |
| Cu | 0.1205 | 0.0057 | 12.7 |
| Mn | 1.81 | 0.16 | 12.7 |
| Mo | 0.167 | 0.040 | 12.7 |
| Ni | 11.18 | 0.21 | 12.7 |
| Si | 0.536 | 0.011 | 12.7 |
| Ti | 0.346 | 0.057 | 12.7 |

Table 2. Reference Values for SRM 1171 Stainless Steel (Cr 17-Ni 11-Ti 0.3)

| Constituent | Mass Fraction (%) | Expanded Uncertainty (Mass Fraction, %) | Coverage Factor, <i>k</i> |
|-------------|-------------------|---|---------------------------|
| Co | 0.097 | 0.079 | 12.7 |

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

Table 3. Information Values for SRM 1171 Stainless Steel (Cr 17-Ni 11-Ti 0.3)

| Constituent | Mass Fraction (%) |
|-------------|-------------------|
| P | 0.019 |
| S | 0.013 |
| W | 0.012 |

REFERENCES

- [1] Thompson, A.; 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 (2008); available at <http://www.nist.gov/pml/pubs/sp811/index.cfm> (accessed June 2014).
- [2] May, W.; Parris, R.; Beck II, C.; Fassett, J.; Greenberg, R.; Guenther, F.; Kramer, G.; Wise, S.; Gills, T.; Colbert, J.; Gettings, R.; MacDonald, B.; *Definitions of Terms and Modes Used at NIST for Value-Assignment of Reference Materials for Chemical Measurements*; NIST Special Publication 260-136; U.S. Government Printing Office: Washington, DC (2000); available at: <http://www.nist.gov/srm/publications.cfm> (accessed June 2014).
- [3] JCGM 100:2008; *Evaluation of Measurement Data — Guide to the Expression of Uncertainty in Measurement (GUM 1995 with Minor Corrections)*; Joint Committee for Guides in Metrology (JCGM) (2008); available at http://www.bipm.org/utis/common/documents/jcgm/JCGM_100_2008_E.pdf (accessed June 2014); 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://www.nist.gov/pml/pubs/index.cfm> (accessed June 2014).
- [4] Hahn, G.J.; Meeker, W.Q.; *Statistical Intervals: A Guide for Practitioners*; John Wiley & Sons, Inc., New York (1991).

Certificate Revision History: 25 June 2014 (Editorial changes); 23 September 2009 (This revision reports revised assignments and values for all constituents based on re-evaluation of the original analytical results and updates the entire certificate to current NIST standards); 26 May 1993 (This revision reflects program and organizational changes at NIST and the Department of Commerce); 05 September 1985 (Original certificate date).

Users of this SRM should ensure that the Certificate of Analysis in their possession is current. This can be accomplished by contacting the SRM Program: telephone (301) 975-2200; fax (301) 948-3730, email srminfo@nist.gov; or via the Internet at <http://www.nist.gov/srm>.

Appendix. Analytical Methods

| Element | Methods* |
|---------|-----------|
| C | 4 |
| Co | 1, 11 |
| Cr | 1, 14, 15 |
| Cu | 1 |
| Mn | 3, 12 |
| Mo | 2, 13 |
| Ni | 6 |
| P | 2 |
| S | 5 |
| Si | 7, 8 |
| Ti | 10 |
| W | 9 |

*Key to Methods:

1. Atomic absorption spectroscopy
2. Colorimetric – direct
3. Colorimetric – oxidation with ammonium persulfate with AgNO₃
4. Combustion – gas chromatography
5. Combustion – iodometric titration
6. Gravimetric – dimethylglyoxime, NaCN titration
7. Gravimetric – perchloric acid – double dehydration
8. Gravimetric – perchloric acid – single dehydration
9. Photometric – a-benzoinoxime with Mo, fluoride ion exchange, dithio extraction, spectrophotometric
10. Photometric – spectrophotometric diantipyrylmethane
11. Photometric – spectrophotometric nitroso R
12. Photometric – spectrophotometric periodate
13. Photometric – spectrophotometric thiocyanate
14. Titrimetric – persulfate oxidation and potentiometric titration with ferrous ammonium sulfate
15. Volumetric – oxidation with ammonium persulfate, reduced with ferrous ammonium sulfate, titrated with KMnO₄