

Brammer Standard Company, Inc.

Certificate of Analysis

BS 2205A

Certified Reference Material for Duplex Alloy 2205 - UNS Number S31803

	Certified Value ¹	Estimate of Uncertainty ²	Certified Values³	Certified Value ¹	Estimate of Uncertainty ²
As	0.0072	0.0007		N	0.004
B	0.0022	0.0004		Nb	0.001
C	0.021	0.001		Ni	0.02
Ca	0.0007	0.0003		O	0.0007
Co	0.071	0.003		P	0.001
Cr	22.73	0.07		S	0.0002
Cu	0.300	0.004		Si	0.01
Fe	66.2	0.2		Sn	0.0006
Mn	1.48	0.01		V	0.002
Mo	3.17	0.01			

	Certified Value ¹	Estimate of Uncertainty ²	Reference Values^{3,4}	Certified Value ¹	Estimate of Uncertainty ²
Al	0.004	0.001		W	0.01
Ti	0.002	0.001			

Informational Values^{3,5}

Mg (0.0001)

Zr (0.003)

¹ For each element, the certified value listed is the present best estimate of the true value based on the mean of the weighted results of an interlaboratory testing program. See page 3 for more information on its calculation.

² For each element, the uncertainty listed is based on a statistical evaluation of the contributions of homogeneity and the interlaboratory testing program. See page 3 for more information on its calculation.

³ Values are given in weight percent. Values in brackets are reported by difference.

⁴ Reference values are not certified and are provided for information only.

⁵ Values in parentheses are not certified and are provided for information only.

Trace element information values for Bi, Ce, Cl, Ga, Ge, In, Ir, Pb, Pt, Re, Ru, Sb, Y, and Zn are shown on page 4.

The requirements of ISO Guides 30, 31, and 35 were followed for the preparation of this Certified Reference Material and certificate of analysis.

BS 2205A

* Code for method

Certified values listed as weight percent

Analysis	*	As	*	B	*	C	*	Ca	*	Co	*	Cr	*	Cu	*	Fe	*	Mn	*	Mo
1	5	0.006	14	0.0016	1	0.0182	12	0.0003433	14	0.0670333	4	22.5	4	0.250	13	65.69367	8	1.437	4	3.15
2	12	0.0067	7	0.00170	1	0.0193	11	0.0004	11	0.0672	3	22.60	4	0.28767	16	[65.9852]	3	1.47	4	3.1554333
3	15	0.00673667	4	0.0018	1	0.0198333	14	0.0005	4	0.0675333	3	22.72	14	0.29333	4	66.0	4	1.47237	4	3.1573333
4	9	0.00703333	11	0.0021	1	0.0199	4	0.0007367	12	0.0676667	4	22.733833	11	0.297	14	66.00	14	1.47667	4	3.16
5	4	0.00706667	5	0.0021667	1	0.02	4	0.0008333	3	0.0677	13	22.7357	4	0.2992	16	[66.11]	4	1.477	3	3.16
6	4	0.00726667	4	0.0022333	1	0.0202333	4	0.0009	3	0.070	4	22.74	4	0.29933	16	[66.1152]	4	1.47707	4	3.169
7	5	0.00783333	11	0.0023	1	0.0206667	11	0.0009	4	0.0701333	11	22.76	4	0.29943	16	[66.14]	3	1.48	11	3.17
8	3	0.0079	3	0.0023	1	0.0208567	3	0.00093	11	0.0703	11	22.76	3	0.30	16	[66.18]	10	1.48	14	3.1766667
9	11	0.0084	4	0.0023	1	0.0213333			4	0.0728333	13	22.794667	10	0.30	16	[66.3]	11	1.48	11	3.18
10	5	0.0090	3	0.00234	1	0.0215667			10	0.073	17	22.7962	3	0.301	16	[66.4033]	4	1.48607	3	3.18
11			4	0.0025667	11	0.0219			4	0.0736	14	22.8	4	0.3028	4	66.8	4	1.488	10	3.18
12			4	0.0026667	11	0.0219			4	0.0740	4	22.802333	11	0.303			4	1.49667	4	3.1922333
13					1	0.0219			4	0.0784333	4	22.843333	4	0.307			11	1.5		
14					3	0.022			10	22.85	5	0.341					4	1.53167		
15					3	0.0225														
Average		0.00721		0.002197		0.02127		0.00069		0.070726		22.7335		0.2996		66.206		1.4829		3.169222
Std Dev		0.00031		0.000068		0.00080		0.00011		0.000088		0.0037		0.0041		0.056		0.0058		0.000091
H		0.00093		0.00057		0.0015		0.00037		0.0027		0.073		0.0056		0.15		0.014		0.021
U ₁		0.00098		0.00058		0.0017		0.00039		0.0027		0.073		0.0069		0.16		0.015		0.021
t-statistic		2.26		2.20		2.14		2.36		2.18		2.16		2.16		2.23		2.16		2.20
U ₂		0.0022		0.0013		0.0037		0.00092		0.0058		0.16		0.015		0.35		0.032		0.047
U ₃		0.00070		0.00037		0.0010		0.00032		0.0016		0.042		0.0040		0.11		0.0085		0.013
Certified		0.0072		0.0022		0.021		0.0007		0.071		22.73		0.300		66.2		1.48		3.17
Uncertainty		0.0007		0.0004		0.001		0.0003		0.003		0.07		0.004		0.2		0.01		0.01
Tolerance		0.0022		0.0013		0.004		0.0007		0.009		0.21		0.015		0.6		0.03		0.05

Analysis	*	N	*	Nb	*	Ni	*	O	*	P	*	S	*	Si	*	Sn	*	V
1	2	0.14753333	5	0.0071667	4	5.23	2	0.0038667	10	0.028	1	0.0004	4	0.51567	12	0.004767	11	0.0795
2	2	0.15066667	5	0.0084633	3	5.23	2	0.0041	4	0.0283333	1	0.0004333	11	0.523	5	0.004867	11	0.0812
3	2	0.15333333	11	0.009	4	5.2393333	2	0.0041367	4	0.0284	12	0.00045	11	0.523	3	0.0057	4	0.08123
4	2	0.15433333	4	0.0092333	6	5.2453333	2	0.0042	5	0.0287333	1	0.0005	4	0.524	9	0.005867	4	0.08157
5	2	0.15666667	4	0.0092333	13	5.2456667	10	0.0045	14	0.0287333	1	0.0006333	6	0.52733	4	0.005933	4	0.08163
6	2	0.15766667	5	0.0097667	4	5.2566667	2	0.00464	11	0.0289	1	0.0006667	4	0.5296	5	0.006	3	0.082
7	2	0.15953333	3	0.0102	3	5.26	2	0.0050	3	0.029	1	0.0006833	3	0.53	4	0.0061	4	0.08207
8	3	0.16	14	0.0104	14	5.26	2	0.0054733	4	0.0291333	1	0.00073	14	0.53267	4	0.006287	3	0.0834
9	2	0.16	3	0.011	10	5.27	2	0.0058	4	0.0294333	1	0.0007467	4	0.5336	4	0.006367	4	0.08413
10	2	0.16033333	11	0.0112	4	5.2715			4	0.0298	3	0.0008	6	0.53437	11	0.0067	4	0.0843
11	2	0.1610	4	0.0113	4	5.2733333			11	0.0299	1	0.0014333	4	0.53667	5	0.006933	5	0.0852
12	2	0.164			4	5.2819667			3	0.0306			3	0.54			14	0.0859
13					4	5.2826667			4	0.0310			10	0.54			10	0.086
14					4	5.2978333							4	0.547				
Average		0.1573		0.00965		5.260307		0.00440		0.029228		0.000635		0.5275		0.00584		0.0827
Std Dev		0.0039		0.00048		0.000085		0.00024		0.000088		0.000075		0.0044		0.00026		0.0022
H		0.0040		0.0011		0.029		0.00076		0.0017		0.0003603		0.00756		0.00085		0.0029
U ₁		0.0056		0.0012		0.029		0.00079		0.0017		0.00037		0.0087		0.00089		0.0036
t-statistic		2.20		2.23		2.16		2.31		2.18		2.23		2.16		2.23		2.18
U ₂		0.012		0.0026		0.062		0.0018		0.0038		0.00082		0.019		0.0020		0.0078
U ₃		0.0035		0.00078		0.017		0.00061		0.0011		0.00025		0.0050		0.00060		0.0022
Certified		0.157		0.010		5.26		0.0046		0.029		0.0006		0.53		0.0058		0.083
Uncertainty		0.004		0.001		0.02		0.0007		0.001		0.0002		0.01		0.0006		0.002
Tolerance		0.012		0.003		0.06		0.0021		0.004		0.0006		0.03		0.0020		0.008

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* Code for method

Reference values listed as weight percent

Analysis	*	Al	*	Ti	*	W
1	12	0.00090667	12	0.0006767	4	0.0153667
2	5	0.0012	5	0.0011667	12	0.0160
3	5	0.00192	4	0.0013	5	0.0165667
4	11	0.0046	5	0.00139	4	0.0168667
5	14	0.0047	11	0.0016	3	0.019
6	5	0.00493333	5	0.0016667	4	0.0192
7	3	0.0051	11	0.0017	11	0.0199
8	4	0.0052	3	0.002	10	0.020
9	4	0.00533333	14	0.0022333	4	0.0216333
10	4	0.0055	4	0.0024	4	0.0220333
11	11	0.0057	4	0.0026	3	0.0231
12			10	0.003	11	0.0248
13			3	0.003		
Average		0.00393		0.002057		0.02053
Std Dev		0.00016		0.000089		0.00084
H		0.00072		0.0005592		0.0015
U ₁		0.00074		0.00057		0.0017
t-statistic		2.23		2.18		2.20
U ₂		0.0017		0.0012		0.0038
U ₃		0.00050		0.00034		0.0011
Certified		0.004		0.002		0.02
Uncertainty		0.001		0.001		0.01
Tolerance		0.003		0.002		0.02

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* Code for method

Informational values listed as weight percent

Analysis	*	Mg	*	Zr
1	12	0.0000933	5	0.00003
2	4	0.0001	4	0.0039667
3	5	0.00013	3	0.004
4	3	0.00017	3	0.0057
5	4	0.00019333		
Average		0.000137		0.003
Std Dev		0.000053		0.027
H		0.00022		0.001
U ₁		0.00022		0.027
t-statistic		2.78		3.18
U ₂		0.00062		0.087
U ₃		0.00028		0.044
Informational		(0.0001)		(0.003)

For each element, in accordance with the requirements of ISO 17034 and Guide 35, an effort must be made to account for the effects on the certified value of the uncertainty estimate from homogeneity testing (H) and the uncertainties of the contributing laboratories. The average (A) is calculated using a weighted mean where the reciprocal of the square of each laboratory's combined uncertainty (C_L), calculated from its standard deviation (S_L) and its uncertainty estimate (U_L), is used as the weight (W_L) for its mean (M_L). The standard deviation (S) is calculated as the square root of the reciprocal of the sum of the weights. U₁ is the combined uncertainty from homogeneity and labs. U₂ is U₁ multiplied by the coverage factor (95 % t-statistic). U₃ is U₂ divided by the square root of the number of determinations (n). Thus:

$$C_L = \sqrt{S_L^2 + U_L^2} \quad W_L = \frac{1}{C_L^2} \quad A = \frac{\sum_{i=1}^n W_L M_L}{\sum_{i=1}^n W_L} \quad S = \frac{1}{\sqrt{\sum_{i=1}^n W_L}} \quad U_1 = \sqrt{H^2 + S^2} \quad U_2 = t \times U_1 \quad U_3 = \frac{U_2}{\sqrt{n}}$$

All but the final reported values are taken to two significant figures as determined by each quantity's uncertainty estimate. The final reported Uncertainty is U₃ rounded to one significant figure and represents the half width of the 95 % confidence interval for the **Certified** value. The final reported **Certified** value is A rounded to the same decimal place as the Uncertainty. The Uncertainty is a measure of the quality of the **Certified** value.

The Tolerance is a measure of the expected performance of an analysis. This involves further expanding the sample uncertainty to include instrument and operator uncertainty, for those without access to such calculations. For further information regarding the confidence interval for the certified value see ISO Guide 35:2006 section 6.

Analysis	*	Bi	*	Ce	*	Cl	*	Ga	*	Ge	*	In	*	Ir	*	Pb	*	Pt	*	Re
1	12	0.01	12	0.006	12	0.01	12	24	12	5.8	12	0.19	12	0.10	12	0.31	12	0.16	12	2.7
2	12	0.01	12	0.008	12	0.01	12	25	12	6.0	12	0.21	12	0.16	12	0.32	12	0.17	12	2.8
3			12	0.010	12	0.05	12	25	12	6.0	12	0.21	12	0.17	12	0.33	12	0.18	12	2.9
Analysis	*	Ru	*	Sb	*	Y	*	Zn												
1	12	0.06	12	13	12	0.01	12	1.7												
2	12	0.12	12	14	12	0.01	12	1.8												
3	12	0.15	12	14	12	0.02	12	2.1												

Analytical Method Codes:

1	Combustion (ASTM E1019)	7	Photometric	13	Titrimetric
2	Fusion (ASTM E1019)	8	Flame Atomic Absorption	14	DCP Atomic Emission
3	Spark Atomic Emission	9	GF Atomic Absorption	15	HG Atomic Fluorescence
4	ICP Atomic Emission	10	X-Ray Fluorescence	16	Difference
5	ICP Mass Spectrometry	11	GD Atomic Emission	17	WET
6	Gravimetric	12	GD Mass Spectrometry		

ICP = Inductively Coupled Plasma GF = Graphite Furnace GD = Glow Discharge
 DCP = Direct Current Plasma HG = Hydride Generation

Lab Name	Location	Registrar	Accreditation
Brammer Standard Company, Inc.	Houston, TX	A2LA	17025, 17034
NSL Analytical	Cleveland, OH	ANAB	17025
LECO Corporation	St. Joseph, MI	A2LA	17025
Dirats Laboratories	Westfield, MA	ANAB	17025
Evans Analytical Group	Liverpool, NY	A2LA	17025
Instytut Metalurgii Zelaza	Gliwice, Poland	PCA	17025
Luvak Inc.	Boylston, MA	PRI	17025
Exova	Glendale Heights, IL	A2LA	17025
National Analysis Center For Iron And Steel	Beijing, China	CNAS	17025
TUV Rheinland Pvt Ltd	Bangalore, India	NABL	17025
Laboratory Testing, Inc.	Hatfield, PA	PRI	17025

A2LA = American Association for Laboratory Accreditation
 ANAB = ANSI-ASQ National Accreditation Board
 CNAS = China National Accreditation Service
 NABL = National Accreditation Board for Testing and Calibration Laboratories
 PCA = Polish Center For Accreditation
 PRI = Performance Review Institute

Analysis: Chemical analyses were made on solid pieces and chips prepared by or an end mill from representative samples for the certified portion of the lot in accordance with ASTM Standard Practice E1806. The laboratories participating in the testing followed the requirements of ISO Standard 17025.

Traceability: The following Certified Reference Materials were used to validate the analytical data: 13X31200A; AR 512, 646, 654, 657, 662, 673, 675, 876, 882, 892, 1647, 1648, 1650, 1651, 1652, 1653; BAS 149/3, 220/2, 342, 410/2, 431, 433, 435, 459, 460, 460/1, 464/1, 466/2; BS H-13, LF2B, 34D, 36D, 50G, 56H, 61G, 81G, 177, 179B, 179C, 180B, 288, 304A, 304B, 316D, 316E, 318, 410C, 1009, 1020, 2205; CKD 180A, 188A; DSZU CA013; ECRM 284-1, 294-1; IARM 20A, 212D; IMZ 110A, 114A, 130, 153A, 163A, 164, 174; JK 37; LECO 501-644, 502-414, 502-449, 502-712, 502-855, 502-887, 502-894, 502-916, 502-918, 502-928, 502-935, 502-946, 502-970; NCS NS 21006; SRM 153E, 160B, 345, 361, 363, 365, 1155A, 1265, 1765, 1766, 3107, 3109A, 3131A.

Homogeneity: This Certified Reference Material (CRM) was tested for homogeneity using ASTM Standard Method E826 and found acceptable. It was also examined by spark atomic emission spectrometry and found to be compatible with the following Reference Materials — BAS 410/2, 466/2; BS 81G, 177, 179B, 318; ECRM 281-1; IARM 20A; IMZ 163A, 164; LECO 502-887; NCS NS 21006.

Validity statement: ISO Guide 31 states that the certification should contain an expiration date for all materials where instability has been demonstrated or is considered possible, after which the certified value is no longer guaranteed by the certifying body. The certification of BS 2205A is valid indefinitely. The certification is nullified if this CRM is damaged, contaminated, or otherwise modified.

Storage: This CRM must be stored in a cool, dry, non-corrosive environment.

Source: The bar stock for this CRM was produced by Next Generation Metals, Inc., Boca Raton, FL.

Form: This CRM is machined in the form of a disc, approximately 38 mm in diameter and 19 mm thick by Brammer Standard Company, Inc.

Use: This CRM is intended for use in spark atomic emission, glow discharge, and x-ray spectrometric methods of analysis. Refer to ISO Guide 33 for information about the use of Certified Reference Materials.

Certified Area: The entire depth of the CRM may be used.

Caution: As with any bar material, avoid spark atomic emission spectrometric burns in the center of the CRM (5 mm radius), as some segregation may be present.

Sample Preparation: For best analytical results, use the same method for preparing the analytical surface on all reference materials as used for production specimens. Avoid overheating the sample during surface preparation.

Caution: CRM contains significant insoluble soft metal inclusions. Surface smearing may occur. Spark atomic emission spectrometers may require extended preburns to compensate.

Certificate Number: The unique identification number for this certificate of analysis is 2205A-100219. You may obtain information on revisions of certificates from the internet at www.brammerstandard.com.

Safety Notice: A Safety Data Sheet (SDS) is not required for this material. This material will not release or otherwise result in exposure to a hazardous chemical, under normal conditions of use. Inquiries concerning this Reference Material should be directed to:

Brammer Standard Co., Inc.
14603 Benfer Road
Houston, Texas 77069-2895 USA

Phone: (281) 440-9396 Web: www.brammerstandard.com

Fax: (281) 440-4432 Email: contact@brammerstandard.com

Brammer Standard Company, Inc., is accredited by the American Association For Laboratory Accreditation (A2LA) to ISO Standard 17034 as a Reference Material Producer for the production of Certified Reference Materials and Reference Materials (Certificate Number 656.02)

Brammer Standard Company's Chemical Laboratory is accredited by A2LA to ISO Standard 17025. (Certificate Number 656.01)

By Certificate Number 10539, the Quality System of Brammer Standard Company, Inc., is registered to ISO 9001 by National Quality Assurance (NQA), U.S.A.

The scopes of accreditation are listed on the website: www.brammerstandard.com

References:

Versions used were those available at the time of testing and characterization

- E826 Standard Practice for Testing Homogeneity of a Metal Lot or Batch in Solid Form by Spark Atomic Emission Spectrometry
- E1019 Standard Test Methods for Determination of Carbon, Sulfur, Nitrogen, and Oxygen in Steel, Iron, Nickel, and Cobalt Alloys by Various Combustion and Fusion Techniques
- E1806 Standard Practice for Sampling Steel and Iron for Determination of Chemical Composition

ISO Standard 17025:2005 General requirements for the competence of testing and calibration laboratories

ISO Standard 9001:2015 Quality Management Systems - Requirements

ISO Guide 30:2015 Terms and definitions used in connection with reference materials + 2008 amendment

ISO Guide 31:2015 Reference materials - Contents of certificates and labels

ISO Guide 33:2015 Uses of certified reference materials

ISO Standard 17034:2016 General requirements for the competence of reference material producers

ISO Guide 35:2006 Reference Materials - General and statistical principles for certification

ASTM documents available from ASTM, 100 Barr Harbor Dr., West Conshohocken, PA 19428.

ISO Guides and Standards available from Global Engineering - www.global.ihs.com

Other useful documents available from NIST, U.S. Department of Commerce, Gaithersburg, MD 20899.

NIST Special Publication 260-100, Handbook for SRM Users

NIST Special Publication 829, Use of NIST Standard Reference Materials for Decisions on Performance of Analytical Chemical Methods and Laboratories

Certified by: _____ on October 2, 2019.

Beau R. Brammer

President