

CERTIFICATE OF ANALYSIS

IMZ 187A

CERTIFIED REFERENCE MATERIAL NICKEL ALLOY

Analysis listed as percent by weight [% m/m]

	Certified value	Expanded Uncertainty		Certified value	Expanded Uncertainty
Al	4.93	± 0.09	Mo	1.86	± 0.04
B	0.015	± 0.001	Nb	0.011	± 0.003
C	0.110	± 0.003	Ni	59.7	± 0.3
Co	9.75	± 0.09	Ta	3.75	± 0.06
Cr	8.85	± 0.22	Ti	2.35	± 0.05
Fe	0.11	± 0.01	W	6.91	± 0.12
Hf	1.55	± 0.09	Zr	0.030	± 0.002

Expanded uncertainty bases on statistical evaluation of the contributions the interlaboratory certification analysis and the material homogeneity

Certificate Number: IMZ 187A-140224

Certificate revision history on page 4

Analysis	Al	*	B	*	C	*	Co	*	Cr	*	Cu**	*	Fe	*	Hf	*
1	4,662	5	0,0118	7	0,111	2	9,6346	7	8,67	1	0,0003	6	0,095	7	1,593	7
2	4,807	1	0,013	7	0,101	2	9,6409	7	8,747	1	0,00056	7	0,0314	5	1,4540	7
3	4,81	7	0,0137	7	0,105	2	9,69	1	8,760	5	0,00065	7	0,10	14	1,5065	7
4	4,817	7	0,0138	7	0,1066	2	9,71	1	8,777	7	0,0010	7	0,102	7	1,51	1
5	4,8921	7	0,0146	7	0,108	2	9,719	7	8,81	7	0,001	14	0,1048	7	1,525	7
6	4,91	1	0,0152	7	0,1081	2	9,7305	7	8,82	7	0,0010	7	0,1067	7	1,529	7
7	4,9423	7	0,0153	5	0,1089	2	9,735	5	8,8279	7	0,0020	7	0,1082	7	1,54	1
8	4,949	7	0,0156	7	0,1093	5	9,75	1	8,85	1	0,0036	5	0,1085	7	1,5683	7
9	4,95	7	0,0157	5	0,110	2	9,761	7	8,9118	10	0,0096	5	0,11	1	1,60	7
10	4,98	1	0,016	5	0,1108	2	9,79	7	8,9134	7			0,112	5	1,634	5
11	5,0099	7	0,0178	5	0,1120	2	9,81	7	8,92	1			0,1139	7	1,7421	5
12	5,03	7			0,1126	2	9,8060	5	8,9410	5			0,123	1		
13	5,0530	5			0,114	5	9,85	7	8,97	7			0,125	7		
14	5,31	1			0,1202	5	9,932	1	9,040	7			0,131	1		
Average ¹	4,9311		0,01487		0,1097		9,7483		8,8541		0,0012		0,1087		1,5519	
SD ²	0,1004		0,0012		0,0029		0,0683		0,0924		0,0007		0,0092		0,0498	
u characterization ³	0,0336		0,00044		0,0010		0,0229		0,0310		0,00027		0,0031		0,0188	
u homogeneity ⁴	0,026		0,00040		0,0014		0,037		0,103		0,00007		0,0027		0,040	
Certified value ⁵	4,93		0,015		0,110		9,75		8,85				0,11		1,55	
Expanded uncertainty ⁶	0,09		0,001		0,003		0,09		0,22				0,01		0,09	

Analysis	Mn**	*	Mo	*	Nb	*	Ni	*	P**	*	S**	*	Si**	*	Ta	*
1	0,00050	7	1,885	7	0,0047	5	59,9	7	0,00047	7	0,0001	2	0,0058	5	4,005	7
2	0,00083	6	1,744	1	0,007	7	59,06	5	0,0005	1	0,0002	2	0,015	7	3,4465	7
3	0,001	14	1,7536	5	0,009	7	59,58	7	0,0011	7	0,00025	7	0,0156	7	3,492	7
4	0,0015	7	1,8028	7	0,01	1	59,60	7	0,0011	7	0,00028	2	0,0160	7	3,59	1
5	0,0018	7	1,84	1	0,0101	7	59,7	1	0,0012	6	0,0003	2	0,02	7	3,7344	5
6	0,0043	5	1,840	5	0,0102	6	59,71	8	0,0022	5	0,00032	2	0,0249	7	3,74	7
7	0,0085	5	1,84	7	0,011	1	59,75	1	0,0024	5	0,0007	2	0,025	1	3,75	1
8	0,0095	7	1,86	1	0,0118	7	60,00	7	0,003	1	< 0,0001	5	0,030	7	3,76	1
9			1,868	7	0,0128	7			< 0,002	7	< 0,0005	2	0,0537	7	3,787	5
10			1,8773	7	0,020	7					< 0,002	2	0,0541	7	3,8017	7
11			1,881	7	0,022	5							0,0607	5	3,810	7
12			1,9662	7	< 0,05	1									3,8342	7
13			1,98	7												
14			2,02	1												
Average ¹	0,0021		1,8628		0,0105		59,6739		0,0014		0,0003		0,0263		3,7507	
SD ²	0,0014		0,0385		0,0024		0,1365		0,0008		0,0001		0,0139		0,0764	
u characterization ³	0,00063		0,0129		0,0009		0,0605		0,00038		0,00003		0,0053		0,0277	
u homogeneity ⁴	0,00013		0,016		0,0013		0,142		0,00005				0,0012		0,0044	
Certified value ⁵			1,86		0,011		59,7								3,75	
Expanded uncertainty ⁶			0,04		0,003		0,3								0,06	

Analysis	Ti	*	W	*	Zr	*	Mg**	*	Re**	*	V**	*
1	2,02	5	7,08	7	0,0191	5	0,00115	7	0,00000	7	0,00101	7
2	2,223	1	5,95	7	0,027	7	0,0022	6	0,0016	7	0,0018	5
3	2,296	5	6,46	1	0,0275	7	0,00227	7	0,002	7	0,0020	6
4	2,30	1	6,7975	7	0,0287	7	0,0043	7	0,0021	6	0,0027	7
5	2,3089	7	6,815	7	0,030	7	< 0,01	14	0,0057	7	0,004	7
6	2,32	7	6,86	1	0,030	1			0,0061	7	0,0046	7
7	2,34	1	6,867	5	0,03	1			0,0081	5	0,0098	7
8	2,36	1	6,87	1	0,0302	7			0,040	5	0,0190	5
9	2,36	7	6,9159	7	0,0302	7			< 0,05	1	< 0,010	7
10	2,3751	7	6,9190	7	0,0303	7						
11	2,40	7	6,99	7	0,031	5						
12	2,417	7	7,003	1	0,031	1						
13	2,4327	7	7,196	1	0,0316	7						
14	3,581	7	7,3760	5								
Average ¹	2,3465		6,9066		0,0297		0,0023		0,00431		0,00366	
SD ²	0,0677		0,1420		0,0013		0,0010		0,00331		0,00214	
u characterization ³	0,0227		0,0476		0,0005		0,00060		0,0015		0,00095	
u homogeneity ⁴	0,00043		0,033		0,00063							
Certified value ⁵	2,35		6,91		0,030							
Expanded uncertainty ⁶	0,05		0,12		0,002							

* - analytical method used

** - informative values

All values are based on recommendations of the ISO GUIDE 35:2017(E) standard:

1. **Average** is calculated according to Algorithm A (Guide clause A.2.3.4: Robust statistics);
2. **Standard deviation** is calculated according to Algorithm A (Guide clause A.2.3.4: Robust statistics);
3. **Uncertainty of material characterization** is based on the data obtained from the analysis performer by Network of competent labs (Guide clause 9.5) and calculated according to Guide clause B.5.2;
4. **Uncertainty associated with homogeneity** of material is calculated in agreement with Guide clause 7.11 (Uncertainty evaluation from homogeneity studies);
5. **Certified value** is the average value rounded to one or two significant digits of expanded uncertainty;
6. **Expanded uncertainty** is an geometric average of u characterization and u homogeneity multiplied by coverage factor $k = 2$.

Certification Process: Both preparation of this Reference Material and certification process were prepared according to requirements PN-EN 17034 and ISO GUIDE 35:2017(E)

Chemical Analysis: Chemical analyses were carried out on chips prepared by milling and also for bulk samples. Single values in the above table are the means obtained by individual laboratories. The following methods were used for analysis:

- 1 – wavelength dispersive x-ray fluorescence spectrometry,
- 2 – high frequency infra red absorption,
- 5 – spark atomic emission spectrometry,
- 6 – inductive coupled plasma mass spectrometry,
- 7 – inductive coupled plasma atomic emission spectrometry,
- 8 – gravimetry,
- 10 – titrimetry,
- 14 – graphite furnace atomic absorption spectrometry.

Participating Laboratories:

- Bundesanstalt für Materialforschung und -prüfung (BAM), DAKKs accreditation D-PL-11075-14-00, ISO 17025, (Germany)
- Consolidated Precision Products, Rzeszów, NADCAP accreditation no. 15554182566 (Poland)
- Dirats Laboratories, Westfield, MA, ANAB accreditation AT-1546, ISO 17025, (USA)
- Dunafer Labor Nonprofit Kft., Dunaújváros, NAH accreditation NAH-1-1798/2021, ISO 17025, (Hungary)
- Genitest Inc Montreal, PRI accreditation 123077, ISO 17025, (Canada)
- Laboratory Testing Inc., Hatfield, PA, A2LA accreditation 0117.05, ISO 17025, (USA)
- Lithea, Ltd., Brno, (Czech Republic)
- OnderzoeksCentrum voor de Aanwending van Staal, Zelzate, (Belgium)
- Sieć Badawcza Łukasiewicz - Górnośląski Instytut Technologiczny, Gliwice, PCA accreditation AB 554, ISO 17025, (Poland)
- Sieć Badawcza Łukasiewicz - Instytut Metali Nieżelaznych, Gliwice, PCA accreditation AB 274, ISO 17025, (Poland)

Homogeneity: The homogeneity of this Reference Material was evaluated in accordance with guidelines of ISO GUIDE 35:2017(E). Optical emission spectrometry with spark excitation method was used

Traceability: This Reference Material was found traceable to the following CRMs:

Alpha Aesar 104923A97, BS H2E, BS H3, BS 500B, BS 500D, BS 718D, BS 718C, ECRM 285-2, Eltra 92400-3062, IARM 62E, IARM 68F, IARM 332A, IARM 333A, IMZ 180, IMZ 182, IMZ 187, Leco 501-501, Leco 501-502, Leco 501-510, MBH 28x7183U, MBH 210x11979g, MBH 22x1052C, MBH 10221B, MBH 11221C, MBH 11775C, MBH 11979C, MS Cal Standard A 031823, MS Cal Standard B 031823, MS Cal Standard C 031823, NBS 1197, NBS 1199, NBS 1200, NBS 1201, NBS 1206-2, NBS 1207, NBS 1208-2, Ni10Co10W 042723, Willan 755-B, IV CCS-5 5ug-g 042023, IV CCS-6 5ug-g 042023, pure standards from Merck KGaA, PerkinElmer, SCP Science, VHGlabs and VWR Chemicals.

Available form: 1/4 section of 88 mm cylinder and 20 mm high

Intended use: This Reference Material is intended for use in spark atomic emission and X-ray spectrometric methods

Validity of certification: The certification of IMZ 187A is valid indefinitely within the uncertainty specified provided this Reference Material is stored in dry place and in environment free from chemical or other aggressive vapours. Periodic recertification is not required. The certification is nullified if this Reference Material is damaged, contaminated or otherwise modified

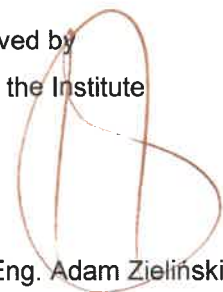
Safety: This Reference Material and packing does not contain substances which can directly influence health

Storage: This Reference Material should be stored in dry place and in environment free from chemical or other aggressive vapours

Inquiries regarding this Reference Material should be directed to rm@git.lukasiewicz.gov.pl

Approved by
Director of the Institute

Prof. Dr. Hab. Eng. Adam Zieliński



Certificate issue date: 14 February 2024

Certificate revision history:

14 February 2024 (Supplement in the data from certification analyses)

27 November 2023 (Original certificate date)