APPLICATION NOTE

FOUNDRY-MASTER SMART

HITACHI
Inspire the Next

Sub-programs & Calibration Ranges

FOUNDRY-MASTER Smart

Metals analysis on your desktop

The FOUNDRY-MASTER Smart is the ideal solution for the metal production and processing industry, providing cost-effective, reliable analysis. This new generation optical emission spectrometer offers high analytical performance at an extremely compact size for seamless quality control in metal production and processing at multiple stages of the process.

Highlights and applications

- Analyses the majority of metals and their alloys
- High analytical performance from powerful patented optics
- Wavelength range: 172 – 420 nm
- Very short start-up and measurement time
- Identification of duplex steels with nitrogen analysis
- Compact foot-print of just 415 x 665 mm and weighing just 35 kg handling is easy
- Preinstalled GRADE Database for fast and easy grade identification
- Results at your fingertips: wide range of result forms, automatic storage
- Excellent price-performance ratio

SAMPLE PREPARATION FOR Al, Cu, Mg, Pb, Sn, Ti, Zn

Correct sample preparation is very important for precise and accurate OES results. A flat sample surface is essential. To achieve this, different techniques, like grinding or milling, are appropriate, depending on the material and the elements to be analysed.

Our recommendation is to use a milling machine equipped with indexable inserts specified for copper alloys. The machine should be optimised for each Cu alloy.

Alternatively, you can use a turning lathe.

For the results presented in this application note, all copper alloys were milled.

SAMPLE PREPARATION FOR Co, Fe, Ni

Sample preparation is very important for OES if precise and accurate results are required. A flat sample surface is absolutely mandatory. Different techniques like grinding or milling can be appropriate depending on the material and the analytes.

Depending on the material of the analyte, typically aluminum oxide is being used, if low Al concentrations have to be determined, zirconium oxide or silicon carbide are alternatives, grain size 40 – 80.

Cast iron samples are typically prepared with grindstones or cup wheels (stone with segments) while steel is typically prepared with disc or belt grinding machines.

In this case, in order to perform sets of precession measurements, all samples were carefully and appropriately ground on a stationary disc grinder with mesh size 60 Al-corundum paper.

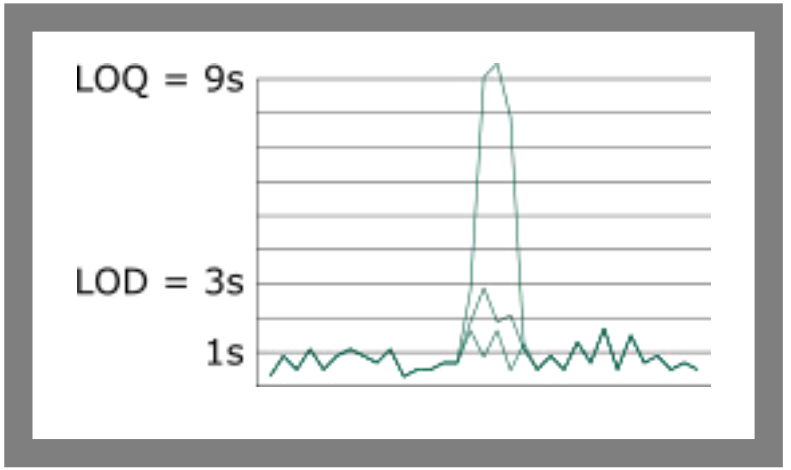
DIFFERENCE BETWEEN LOD AND LOQ

The BEC (equivalent concentration of spectral background) value is the concentration of the analysis sample required to produce the same intensity signal as the background at a given wavelength. The BEC is obtained from the calibration curve and is a fundamental process variable as it directly affects the LOD (**limit of detection**). The LOD is the smallest amount of an element detectable, and it is calculated as follows:

$$LOD = \frac{3}{100} RSD_0 \times BEC$$

RSD_0 is correlated to the relative standard value of spectral background. With the BEC value calculated from the calibration curve, we are able to detect different elements in the matrix down to the level of precision (1δ).

However, the **lowest quantitatively determinable amount** (Limit of Quantitation or LOQ) must be larger than the spectrometric LOD by a multiple of three. The resulting LOQ is the quantitatively readable value with our instrument.



The following tables show the calibration ranges of the FOUNDRY-MASTER Smart.

Slickers. K. 1993. *Automatic-Atomic-Emission-Spectroscopy*. 2nd Edition. D-35334 Giessen. Germany: Brühlsche Universitätsdruckerei

Sub-programs & Calibration Ranges

Sub-programs & Calibration Range Al Base

		Al_000 Orientation		Al_100 Al Low Alloy		Al_200 Al-Cu Alloy		Al_300 Al-Mg Alloy		Al_400 Al-Si Alloy		Al_450 Al-Si/Cu Alloy		Al_500 Al-Zn Alloy		Al_600 Al-Zn/Si Alloy	
		Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
Ag	Silver	0,001	1,2	0,001	1,2	0,001	1,2	0,001	1,2	0,001	1,2	0,001	1,2	0,001	1,2	0,001	1,2
B	Boron	0,0005	0,025	0,0005	0,025	0,0005	0,025	0,0005	0,025	0,0005	0,025	0,0005	0,025	0,0005	0,025	0,0005	0,025
Be	Beryllium	0,0001	0,02	0,0001	0,02	0,0001	0,02	0,0001	0,02	0,0001	0,02	0,0001	0,02	0,0001	0,02	0,0001	0,02
Bi	Bismuth	0,005	0,7	0,005	0,7	0,005	0,7	0,005	0,7	0,005	0,7	0,005	0,7	0,005	0,7	0,005	0,7
Ca	Calcium	0,0001	0,02	0,0001	0,02	0,0001	0,02	0,0001	0,02	0,0001	0,02	0,0001	0,02	0,0001	0,02	0,0001	0,02
Cd	Cadmium	0,001	0,34	0,001	0,34	0,001	0,34	0,001	0,34	0,001	0,34	0,001	0,34	0,001	0,34	0,001	0,34
Ce	Cerium	0,001	0,055	0,001	0,055	0,001	0,055	0,001	0,055	0,001	0,055	0,001	0,055	0,001	0,055	0,001	0,055
Co	Cobalt	0,002	0,5	0,002	0,5	0,002	0,5	0,002	0,5	0,002	0,5	0,002	0,5	0,002	0,5	0,002	0,5
Cr	Chromium	0,001	0,7	0,001	0,7	0,001	0,7	0,001	0,7	0,001	0,7	0,001	0,7	0,001	0,7	0,001	0,7
Cu	Copper	0,003	11	0,003	0,7	0,003	11	0,003	5	0,003	4	0,003	11	0,003	4	0,003	1,5
Fe	Iron	0,002	3	0,002	2,2	0,002	2,2	0,002	3	0,002	3	0,002	2,2	0,002	3	0,002	2,2
Ga	Gallium	0,001	0,15	0,001	0,15	0,001	0,15	0,001	0,15	0,001	0,15	0,001	0,15	0,001	0,15	0,001	0,15
Hg	Mercury	0,005	0,08	0,005	0,08	0,005	0,08	0,005	0,08	0,005	0,08	0,005	0,08	0,005	0,08	0,005	0,08
In	Indium	0,002	0,2	0,002	0,2	0,002	0,2	0,002	0,2	0,002	0,2	0,002	0,2	0,002	0,2	0,002	0,2
La	Lanthanum	0,0005	0,04	0,0005	0,04	0,0005	0,04	0,0005	0,04	0,0005	0,04	0,0005	0,04	0,0005	0,04	0,0005	0,04
Li	Lithium	0,0001	0,035	0,0002	0,035	0,0002	0,035	0,0002	0,035	0,0002	0,035	0,0002	0,035	0,0002	0,035	0,0002	0,035
Mg	Magnesium	0,001	13	0,001	1,5	0,001	1,5	0,001	13	0,001	3	0,001	3	0,001	4	0,001	4
Mn	Manganese	0,001	2,2	0,001	2,2	0,001	2,2	0,001	2,2	0,001	2,2	0,001	2,2	0,001	2,2	0,001	2,2
Mo	Molybdenum	0,001	1	0,001	1	0,001	1	0,001	1	0,001	1	0,001	1	0,001	1	0,001	1
Na	Sodium	0,0001	0,035	0,0002	0,035	0,0002	0,035	0,0002	0,035	0,0002	0,035	0,0002	0,035	0,0002	0,035	0,0002	0,035
Ni	Nickel	0,002	6	0,002	2	0,002	6	0,002	6	0,002	6	0,002	6	0,005	6	0,002	3,5
Pb	Lead	0,001	1,8	0,001	1,8	0,001	1,8	0,001	1,8	0,001	1,8	0,001	1,8	0,001	1,8	0,001	1,8
Sb	Antimony	0,005	0,7	0,005	0,7	0,005	0,7	0,005	0,7	0,005	0,7	0,005	0,7	0,005	0,7	0,005	0,7
Sc	Scandium	0,0005	0,1	0,0005	0,1	0,0005	0,1	0,0005	0,1	0,0005	0,1	0,0005	0,1	0,0005	0,1	0,0005	0,1
Si	Silicon	0,002	28	0,002	1,5	0,002	1,5	0,002	1,5	0,002	28	0,002	28	0,002	28	0,002	1,8
Sn	Tin	0,005	4,5	0,005	1	0,005	4,5	0,005	4,5	0,005	4,5	0,005	4,5	0,005	4,5	0,005	4,5
Sr	Strontium	0,0001	0,16	0,0001	0,16	0,0001	0,16	0,0001	0,16	0,0001	0,16	0,0001	0,16	0,0001	0,15	0,0001	0,16
Ti	Titanium	0,001	0,7	0,001	0,7	0,001	0,7	0,001	0,7	0,001	0,7	0,001	0,7	0,001	0,7	0,001	0,7
V	Vanadium	0,001	0,15	0,001	0,15	0,001	0,15	0,001	0,15	0,001	0,15	0,001	0,15	0,001	0,15	0,001	0,15
Zn	Zinc	0,001	13,5	0,001	2	0,001	2	0,001	5	0,001	2	0,001	2	0,002	13,5	0,001	13,5
Zr	Zirconium	0,001	1	0,001	1	0,001	1	0,001	1	0,001	1	0,001	1	0,001	1	0,001	1

Sub-programs & Calibration Ranges

Sub-programs & Calibration Range Co Base

		Co_000 Global	
		Min	Max
Al	Aluminum	0.003	1.6
B	Boron	0.003	0.2
C	Carbon	0.003	2.8
Cr	Chromium	5	38
Cu	Copper	0.002	0.2
Fe	Iron	0.005	22
Mn	Manganese	0.005	2.3
Mo	Molybdenum	0.003	9
Nb	Niobium	0.003	2.8
Ni	Nickel	0.01	27
P	Phosphorus	0.003	0.06
Pb	Lead	0.003	0.05
S	Sulfur	0.003	0.08
Si	Silicon	0.005	1.8
Sn	Tin	0.002	0.15
Ta	Tantalum	0.005	4.5
Ti	Titanium	0.002	0.5
W	Tungsten	0.005	18
Zr	Zirconium	0.003	0.5

Sub-programs & Calibration Ranges

Sub-programs & Calibration Range Cu Base

		Cu_000 Global		Cu_050 Pure copper		Cu_100 Be/Co/Ag alloy		Cu_200 Cu-Zn brass		Cu_300 Cu-Sn-Pb bronze		Cu_350 Gunmetal		Cu_400 Cu-Ni alloy		Cu_450 Cu-Ni-Zn alloy		Cu_500 Cu-Al alloy	
		Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
Ag	Silver	0.002	5	0.002	0.5	0.002	6	0.002	0.5	0.002	1.2	0.002	1			0.002	0.12		
Al	Aluminum	0.002	12	0.001	1	0.001	0.2	0.002	8	0.001	4	0.001	0.5	0.001	1.7	0.002	0.3	2	13
As	Arsenic	0.002	1.7	0.001	0.5			0.001	0.5	0.001	1.8	0.001	0.55					0.002	0.3
Au	Gold			0.001	0.01														
B	Boron	0.002	0.1	0.002	0.1									0.002	0.1				
Be	Beryllium	0.001	2	0.0002	0.6	0.0002	2.6							0.0001	0.2				
Bi	Bismuth	0.003	7	0.002	0.5			0.002	6	0.003	6	0.002	1	0.001	0.4				
Cd	Cadmium	0.002	1	0.001	1			0.0005	0.6	0.002	0.2	0.002	0.5						
Co	Cobalt	0.003	3.6	0.002	1	0.001	3.6	0.003	0.5	0.002	0.7	0.002	0.25	0.002	0.2	0.002	0.25		
Cr	Chromium	0.001	3.5	0.001	1	0.001	0.1	0.001	0.1	0.002	0.1	0.002	0.1	0.001	3.5				
Fe	Iron	0.005	7.5	0.002	1	0.002	0.2	0.002	2	0.003	2.4	0.002	1	0.002	3	0.002	0.5	0.1	7
Mg	Magnesium	0.0005	0.25	0.0005	0.25									0.0001	0.1			0.0001	0.2
Mn	Manganese	0.002	20	0.001	2	0.002	0.2	0.002	20	0.003	4	0.002	0.6	0.002	4.5	0.002	0.7	0.002	8
Nb	Niobium	0.003	1											0.002	1				
Ni	Nickel	0.005	42	0.001	1	0.002	0.5	0.002	5	0.002	3	0.002	2.2	5	42	5	20	0.002	8
P	Phosphorus	0.002	1	0.002	0.2	0.002	0.1	0.003	0.5	0.002	1.2	0.002	0.3	0.002	0.1	0.002	0.15		
Pb	Lead	0.002	25	0.002	1	0.002	0.25	0.005	5	0.002	25	0.002	10	0.001	0.5	0.002	1.2	0.002	0.5
S	Sulfur	0.002	0.2	0.001	0.2			0.001	0.2	0.001	0.2	0.001	0.2	0.002	0.15	0.002	0.1	0.001	0.2
Sb	Antimony	0.005	4.5	0.003	0.5			0.005	0.5	0.005	4.5	0.005	1.2						
Se	Selenium	0.003	1	0.001	0.1			0.002	0.5	0.003	1								
Si	Silicon	0.003	8.5	0.003	2.2	0.002	1	0.003	4	0.003	7.5	0.003	0.5	0.002	2	0.002	1	0.003	1
Sn	Tin	0.002	20	0.002	1	0.002	0.2	0.002	10	0.002	20	0.002	11	0.002	0.5	0.002	0.5	0.002	1
Te	Tellurium	0.003	1	0.004	0.5														
Ti	Titanium	0.001	0.07											0.001	0.1				
Zn	Zinc	0.003	50	0.003	1	0.005	0.25	0.003	50	0.005	12	0.003	14	0.005	1.5	10	40	0.005	1
Zr	Zirconium	0.001	0.1	0.001	0.1									0.001	0.1				

Sub-programs & Calibration Ranges

Sub-programs & Calibration Range Fe Base

		Fe_000		Fe_100		Fe_150		Fe_200		Fe_250		Fe_300		Fe_305		Fe_400		Fe_500	
		Orientation		Low alloy		Free Cutting Steel		Cast steel		Cr hard & Ni resist		Stainless steel		Stainless steel + N		Tool steel		Mn steel	
		Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
Al	Aluminum	0.005	6	0.002	1.7	0.002	1.7	0.002	1.4	0.002	0.15	0.002	6	0.002	6	0.005	0.5	0.005	0.5
As	Arsenic			0.002	0.1	0.002	0.1	0.002	0.15							0.002	0.1		
B	Boron			0.0005	0.015	0.0005	0.015	0.001	0.11			0.001	0.015	0.001	0.015				
Bi	Bismuth			0.001	0.15	0.001	0.15	0.002	0.025										
C	Carbon	0.005	4	0.003	1.8	0.003	1.8	1.7	5	1	4.5	0.005	2.6	0.005	2.6	0.003	2.75	0.003	1.8
Ca	Calcium			0.0005	0.01														
Ce	Cerium							0.002	0.08										
Co	Cobalt	0.005	13	0.002	1	0.002	1	0.002	0.5	0.004	0.3	0.002	13	0.002	13	0.002	13	0.002	0.4
Cr	Chromium	0.005	40	0.003	5.5	0.003	5.5	0.003	2.5	0.005	40	0.002	35	0.002	35	0.002	22	0.003	5
Cu	Copper	0.005	10	0.003	1	0.003	1	0.003	3.5	0.002	10	0.002	8.5	0.002	8.5	0.001	1	0.002	1
La	Lanthanum							0.001	0.05										
Mg	Magnesium							0.0005	0.125										
Mn	Manganese	0.005	25	0.002	2.5	0.002	2.5	0.003	1.6	0.003	2.4	0.002	18	0.002	18	0.002	2.5	7	22
Mo	Molybdenum	0.005	11	0.002	1.8	0.002	1.8	0.003	2	0.005	4	0.003	8	0.003	8	0.003	11	0.005	2.2
N	Nitrogen													0.05	1.2				
Nb	Niobium	0.005	3	0.001	1.7	0.001	1.7	0.002	0.2	0.003	0.5	0.003	3.5	0.003	3.5	0.001	1.7	0.001	1
Ni	Nickel	0.005	55	0.003	5.5	0.003	5.5	0.005	3.5	0.005	31	0.005	55	0.005	55	0.003	5	0.005	4.5
P	Phosphorus	0.005	0.8	0.002	0.2	0.002	0.2	0.003	0.8	0.003	0.55	0.002	0.17	0.002	0.17	0.002	0.15	0.002	0.15
Pb	Lead	0.005	0.3	0.001	0.15	0.001	0.35	0.003	0.3			0.003	0.3	0.003	0.3				
S	Sulfur	0.005	0.45	0.002	0.125	0.002	0.4	0.002	0.22	0.003	0.25	0.003	0.42	0.003	0.42	0.002	0.15	0.002	0.15
Sb	Antimony			0.005	0.24	0.005	0.24	0.005	0.28			0.005	0.24	0.005	0.24				
Se	Selenium			0.001	0.05	0.001	0.05	0.004	0.07			0.01	0.4	0.01	0.4				
Si	Silicon	0.005	7	0.003	2.4	0.003	2.4	0.003	6	0.005	7	0.005	4.5	0.005	4.5	0.002	1.5	0.002	2
Sn	Tin			0.002	0.3	0.002	0.3	0.003	0.25	0.003	0.25	0.002	0.25	0.002	0.25	0.002	0.35	0.002	0.15
Ti	Titanium	0.005	2	0.001	1	0.001	1	0.001	0.35	0.005	0.35	0.001	2.3	0.001	2.3	0.001	1	0.001	1.2
V	Vanadium	0.005	10	0.001	1	0.001	1	0.002	0.8	0.005	1	0.001	1	0.001	1	0.002	11	0.001	0.5
W	Tungsten	0.025	25	0.005	2	0.005	2			0.01	0.4	0.01	4	0.01	4	0.01	22		
Zn	Zinc			0.002	0.025	0.002	0.025	0.002	0.04										
Zr	Zirconium			0.002	0.5	0.002	0.5	0.003	0.06			0.002	0.4	0.002	0.4				

Sub-programs & Calibration Ranges

Sub-programs & Calibration Range Mg Base

		Mg_000 Global	
		Min	Max
Ag	Silver	0.001	3.6
Al	Aluminum	0.005	13.8
Be	Beryllium	0.0001	0.0036
Ca	Calcium	0.0005	0.5
Cd	Cadmium	0.0005	0.1
Ce	Cerium	0.01	3
Cu	Copper	0.002	3.5
Dy	Dysprosium	0.0005	0.4
Er	Erbium	0.0005	0.18
Fe	Iron	0.005	0.06
Gd	Gadolinium	0.003	0.425
Ho	Holmium	0.0001	0.078
La	Lanthanum	0.003	1.5
Li	Lithium	0.0005	0.15
Lu	Lutetium	0.0001	0.0084
Mn	Manganese	0.0005	2
Nd	Noedymium	0.02	3
Ni	Nickel	0.002	0.05
Pb	Lead	0.005	0.15
Pr	Praseodymium	0.01	0.8
Si	Silicon	0.03	2.5
Sn	Tin	0.002	0.15
Sr	Strontium	0.0005	0.02
Tb	Terbium	0.0001	0.054
Th	Thorium	0.0001	0.0012
Tm	Thulium	0.001	0.02
Y	Yttrium	0.003	6
Yb	Ytterbium	0.0005	0.1
Zn	Zinc	0.01	7.5
Zr	Zirconium	0.002	0.6

Sub-programs & Calibration Ranges

Sub-programs & Calibration Range Ni Base

		Ni_000 Global		Ni_100 Low Alloy		Ni_200 Monel		Ni_300 Nimonic/Waspalloy		Ni_400 Incoloy		Ni_500 Inconel		Ni_600 Hastelloy		Ni_700 MarMalloy	
		Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
Al	Aluminum	0.005	8.5	0.002	1	0.002	5	0.002	8	0.002	0.5	0.002	8	0.002	8	1	8
B	Boron	0.0005	3.25	0.0005	0.05			0.0005	0.25	0.0005	0.5	0.0005	0.5	0.0005	0.5	0.0005	0.5
C	Carbon	0.005	1	0.002	0.5	0.003	1	0.002	0.5	0.002	0.5	0.002	0.5	0.002	0.5	0.002	0.5
Co	Cobalt	0.005	30	0.002	1	0.002	2	0.001	22	0.002	5	0.002	22	0.002	30	2	15
Cr	Chromium	0.003	35	0.001	1	0.002	1	10	24	15	25	10	30	0.002	25	4	30
Cu	Copper	0.003	38	0.002	1	22	38	0.002	1	0.002	4	0.002	3	0.002	2	0.003	2.5
Fe	Iron	0.005	55	0.002	1	0.005	3	0.002	35	35	60	0.002	40	0.002	25	0.002	5
Hf	Hafnium	0.005	2.3													0.005	2.3
Mg	Magnesium	0.0005	0.25	0.0001	0.15	0.0005	0.25	0.001	0.2	0.0005	0.25	0.0005	0.25	0.0005	0.25	0.0005	0.25
Mn	Manganese	0.005	3.3	0.002	1	0.003	3.3	0.002	1	0.002	3	0.002	2	0.002	2	0.002	1
Mo	Molybdenium	0.005	40					0.002	20	0.002	10	0.002	12	0.002	40	0.002	4
Nb	Niobium	0.003	8.5	0.002	1			0.002	8			0.003	8	0.002	5	0.002	2
P	Phosphorus	0.002	0.065	0.002	0.065	0.002	0.065										
Pb	Lead	0.002	0.1			0.002	0.1										
S	Sulfur	0.002	0.15	0.002	0.15	0.002	0.15	0.002	0.15	0.002	0.15	0.002	0.15	0.002	0.15	0.002	0.15
Si	Silicon	0.005	7.8	0.002	0.5	0.002	7	0.002	3	0.005	7.8	0.002	1.5	0.002	2	0.002	8
Sn	Tin	0.002	1					0.002	1	0.002	1	0.002	1	0.002	1	0.002	1
Ta	Tantalum	0.01	7.8													0.01	7.8
Ti	Titanium	0.003	6.5	0.001	1	0.002	2	0.001	6	0.003	5	0.001	6	0.002	5	0.001	5
V	Vanadium	0.003	1.2			0.002	0.5	0.002	1.2			0.003	1.2	0.003	1.2	0.003	1.2
W	Tungsten	0.01	13.5					0.005	4			0.015	5	0.015	7	0.01	13.5
Zr	Zirconium	0.005	0.5					0.002	0.3			0.005	0.5	0.005	0.5	0.005	0.5

Sub-programs & Calibration Ranges

Sub-programs & Calibration Range Sn Base

		Sn_000 Global	
		Min	Max
Ag	Silver	0.001	5
Al	Aluminium	0.0005	0.075
As	Arsenic	0.005	0.66
Au	Gold	0.0005	0.125
Bi	Bismuth	0.0005	1.5
Cd	Cadmium	0.0005	2
Co	Cobalt	0.0005	0.1
Cu	Copper	0.0005	12
Fe	Iron	0.0005	0.15
Ga	Gallium	0.0005	0.05
Hg	Mercury	0.001	0.2
In	Indium	0.0005	0.15
Ni	Nickel	0.0005	1.5
Pb	Lead	0.0005	50
Sb	Antimony	0.0005	17
Se	Selenium	0.0005	0.02
Te	Tellurium	0.0005	0.1
Zn	Zinc	0.0005	3

Sub-programs & Calibration Ranges

Sub-programs & Calibration Range Ti Base

		Ti_000 Global	
		Min	Max
Al	Aluminum	0.005	10
Cr	Chromium	0.005	8
Cu	Copper	0.005	3
Fe	Iron	0.005	3
Mn	Manganese	0.005	8.5
Mo	Molybdenum	0.01	7.5
Nb	Niobium	0.01	2.5
Ni	Nickel	0.005	1
Pd	Palladium	0.005	0.2
Ru	Ruthenium	0.005	0.15
Si	Silicon	0.007	0.8
Sn	Tin	0.002	13.5
Ta	Tantalum	0.0075	1.25
V	Vanadium	0.005	18.5
W	Tungsten	0.01	1.25
Zr	Zirconium	0.005	6

Sub-programs & Calibration Ranges

Sub-programs & Calibration Range Zn Base

		Zn_000		Zn_040		Zn_100		Zn_300		Zn_500	
		Orientation		Zn-Al 2-6% Cu 0-3.5%		Zn-Al 7-15% Cu 0-6.5%		Zn-Al 15-35% Cu 0.5-4%		Remelt	
		Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
Al	Aluminum	0.001	40	1.5	6.5	7	15.5	15	35	0.001	1.5
Bi	Bismuth									0.001	0.15
Cd	Cadmium	0.0005	0.8	0.0005	0.04	0.0005	0.06	0.0005	0.1	0.0005	0.8
Cr	Chromium									0.003	0.15
Cu	Copper	0.001	8	0.001	3.6	0.001	8	0.001	5.5	0.001	1
Fe	Iron	0.005	0.7	0.003	0.2	0.003	0.1	0.003	0.16	0.005	0.7
Mg	Magnesium	0.0001	0.25	0.0001	0.25	0.0001	0.15	0.0001	0.15		
Mn	Manganese	0.001	0.12	0.001	0.12	0.001	0.02	0.001	0.02		
Ni	Nickel			0.003	0.03	0.005	0.02				
Pb	Lead	0.001	2.5	0.001	0.05	0.001	0.08	0.001	2.5	0.001	2.5
Sb	Antimony									0.015	0.3
Si	Silicon	0.001	0.1	0.001	0.1	0.001	0.1				
Sn	Tin	0.001	3	0.001	0.5	0.001	0.15	0.001	0.025	0.001	3
Ti	Titanium					0.0005	0.02				

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Sub-programs & Calibration Ranges

PERFORMANCE DISCLAIMER

Calibration ranges can be extended with customer's samples. Values obtained for certified reference samples only. Samples must be flat grinded or milled.

The published values are averaged data from very different type of material and should be regarded as 'typical' values.

For more information or to get your own sample tested, please contact us here.

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