APPLICATION NOTE

OE750

Sub-programs & Calibration Ranges

OE750 FOR HIGH-DEMAND ALLOYS ANALYSIS

BACKGROUND

The OE750 is a ground-breaking new OES metals analyzer. With low detection limits it covers the complete spectrum of elements in metal.

Fast measurement times, high reliability and low operating costs mean the OE750 is invaluable for everyday analysis and total quality control, with performance on a par with larger and more expensive spectrometers.

This spark spectrometer is designed to meet the exacting requirements for the metals industries, especially those requiring lower detection limits. It is also able to analyze gases such as hydrogen, oxygen and nitrogen.

The OE750 comes with software that makes analysis faster, more accurate and easier to interpret. The data management functionality allows full traceability of results – essential when it comes to audit time.

Optional extras include adapters for wires and small samples, floor stand version, consumables and spare part kits, and sample preparation devices

KEY FEATURES

- Mid pressure system for extreme stability and highest transparency
- Wavelength range: 119 - 670* nm (*766 nm on request)
- State-of-the-art CMOS high dynamic detectors
- High optical resolution
- Minimized maintenance time
- Better reliability from newly developed excitation source

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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.

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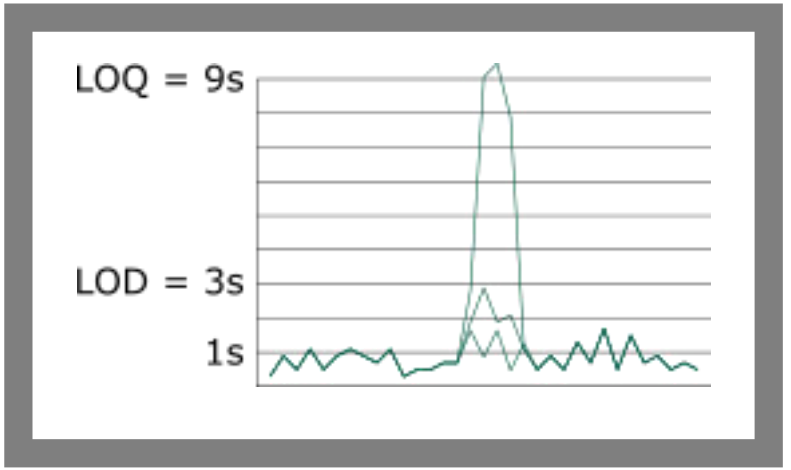
DIFFERENCE BETWEEN LOD AND LOQ

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 and selected sample measurements of the OE750.

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

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Sub-programs & Calibration Ranges

		Al_000		Al_100		Al_200		Al_300		Al_400		Al_450		Al_500		Al_600	
		Orientation		Low Alloy		Al-Cu Alloy		Al-Mg Alloy		Al-Si Alloy		Al-Si/Cu Alloy		Al-Zn Alloy		Al-Zn-Si Alloy	
		Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
Ag	Silver	0.0001	1.2	0.0001	1.2	0.0001	1.2	0.0001	1.2	0.0001	1.2	0.0001	1.2	0.0001	1.2	0.0001	1.2
As	Arsenic	0.003	0.05	0.0003	0.05												
B	Boron	0.0001	0.025	0.0001	0.025	0.0001	0.025	0.0001	0.025	0.0001	0.025	0.0001	0.025	0.0001	0.025	0.0001	0.025
Ba	Barium	0.0001	0.0001	0.0001	0.025	0.0001	0.025	0.0001	0.025	0.0001	0.025	0.0001	0.025	0.0001	0.025	0.0001	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	0.0005	0.75	0.0005	0.75	0.0005	0.75	0.001	0.75	0.001	0.75	0.001	0.75	0.0005	0.75	0.0005	0.75
Ca	Calcium	0.0001	0.025	0.0001	0.02	0.0001	0.02	0.0001	0.02	0.0001	0.02	0.0001	0.025	0.0001	0.02	0.0001	0.02
Cd	Cadmium	0.0002	0.5	0.0002	0.15	0.0002	0.35	0.0002	0.35	0.0002	0.35	0.0002	0.35	0.0002	0.35	0.0002	0.35
Ce	Cerium	0.0002	0.05	0.0002	0.05	0.0005	0.05	0.0005	0.05	0.0002	0.05	0.0002	0.05	0.0005	0.05	0.0005	0.05
Co	Cobalt	0.0003	0.5	0.0003	0.5	0.0003	0.5	0.0003	0.5	0.0003	0.5	0.0003	0.5	0.0003	0.5	0.0003	0.5
Cr	Chromium	0.0002	0.6	0.0002	0.6	0.0002	0.6	0.0002	0.6	0.0002	0.25	0.0002	0.25	0.0002	0.6	0.0002	0.6
Cu	Copper	0.0003	12	0.0003	1	0.001	11	0.0003	0.5	0.0003	1	0.0003	10	0.0003	2.5	0.0003	2.5
Fe	Iron	0.0005	3	0.0005	3	0.0002	3	0.0005	3	0.0005	3	0.0005	3	0.0005	1	0.0005	1
Ga	Gallium	0.0001	0.2	0.0001	0.2	0.0001	0.12	0.0001	0.12	0.0001	0.12	0.0001	0.12	0.0001	0.12	0.0001	0.12
Hg	Mercury	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
In	Indium	0.0001	0.12	0.0001	0.15	0.0005	0.15	0.0005	0.15	0.0005	0.15	0.0005	0.15	0.0001	0.15	0.0001	0.15
La	Lanthanum	0.0001	0.05	0.0001	0.05	0.0005	0.05	0.0005	0.05	0.0005	0.05	0.0005	0.05	0.0001	0.05	0.0001	0.05
Li	Lithium	0.0001	0.025	0.0001	0.025	0.0001	0.025	0.0001	0.025	0.0001	0.025	0.0001	0.025	0.0001	0.025	0.0001	0.025
Mg	Magnesium	0.0005	13	0.0002	2	0.0005	5.5	0.0005	13	0.0005	5	0.0005	5	0.0005	5	0.0005	5
Mn	Manganese	0.0002	2.2	0.0002	2.2	0.0002	2.2	0.0002	0.5	0.0002	0.5	0.0002	0.5	0.0002	1.5	0.0002	1.5
Mo	Molybdenum	0.0002	1	0.0002	1	0.0002	1	0.0002	1	0.0002	1	0.0002	1	0.0002	1	0.0002	1
Na	Sodium	0.0001	0.025	0.0001	0.025	0.0001	0.025	0.0001	0.025	0.0001	0.025	0.0001	0.025	0.0001	0.025	0.0001	0.025
Ni	Nickel	0.0005	5.5	0.0005	1	0.0005	5.5	0.0005	5.5	0.0005	5.5	0.0005	5.5	0.0005	1	0.0005	1
P	Phosphorous	0.0015	0.075	0.0015	0.06	0.0015	0.075	0.0015	0.075	0.0015	0.075	0.0015	0.075	0.0015	0.075	0.0015	0.075
Pb	Lead	0.0002	1.75	0.0002	1.75	0.001	1	0.001	1.75	0.0002	1	0.0002	1	0.001	1	0.001	1
Sb	Antimony	0.001	0.75	0.001	0.2	0.001	0.75	0.001	0.2	0.001	0.2	0.001	0.2	0.001	0.2	0.001	0.2
Sc	Scandium	0.0001	0.06	0.0001	0.06	0.0001	0.06	0.0001	0.06	0.0001	0.06	0.0001	0.06	0.0001	0.06	0.0001	0.06
Si	Silicon	0.0003	28	0.0003	1.5	0.0003	2	0.0003	1.25	1	25	1	25	0.0003	1.5	0.0003	20
Sn	Tin	0.0002	4.2	0.0002	1.25	0.0002	4	0.0002	1.25	0.0002	1.25	0.0002	1.25	0.0002	5	0.0002	5
Sr	Strontium	0.0001	0.15	0.0001	0.15	0.0001	0.15	0.0001	0.15	0.0001	0.15	0.0001	0.15	0.0001	0.2	0.0001	0.15
Ti	Titanium	0.0002	1	0.0002	1	0.0002	0.5	0.0002	1	0.0002	1	0.0002	1	0.0002	1	0.0002	1
Tl	Thallium	0.0003	0.025	0.0003	0.025												
V	Vanadium	0.0003	0.35	0.0003	0.35	0.0003	0.15	0.0003	0.15	0.0003	0.15	0.0003	0.15	0.0003	0.15	0.0003	0.15
Zn	Zinc	0.0005	13	0.0002	2	0.0005	3.5	0.0005	2	0.0005	1	0.0005	1	0.0005	13	0.0005	13
Zr	Zirconium	0.0005	1	0.0005	1	0.0005	1	0.0005	0.25	0.0005	0.25	0.0005	0.25	0.0005	1	0.0005	1

Sub-programs &
Calibration Range Al Base

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Sub-programs & Calibration Ranges

		Co_000		Co_100		Co_200		Co_300	
		Orientation		Low Alloy		Stellite High Ni		Stellite Low Ni	
		Min	Max	Min	Max	Min	Max	Min	Max
Al	Aluminum	0.0005	1.5	0.0005	0.3	0.0005	0.3	0.0005	1.5
B	Boron	0.0002	0.2			0.0002	0.2	0.0002	0.15
C	Carbon	0.0005	2.6	0.0005	0.25	0.0005	2.6	0.0005	2.6
Cr	Chromium	5	40	0.001	1	5	32	5	35
Cu	Copper	0.0002	0.2	0.0002	0.2	0.0005	0.2	0.0005	0.2
Fe	Iron	0.0008	22	0.0008	2	0.001	22	0.0005	3.5
Mn	Manganese	0.005	2.2	0.001	1	0.0005	2.2	0.0005	1.5
Mo	Molybdenum	0.0005	8	0.0005	1	0.0005	1	0.0005	8
N	Nitrogen	0.001	0.2					0.001	0.2
Nb	Niobium	0.0015	2.5			0.0005	0.5	0.001	2.5
Ni	Nickel	0.0005	25	0.0005	1	5	25	0.001	5
P	Phosphorus	0.001	0.05	0.001	0.05	0.003	0.05	0.0005	0.015
Pb	Lead	0.002	0.025					0.002	0.05
S	Sulfur	0.001	0.07	0.001	0.07	0.0005	0.07	0.0005	0.07
Si	Silicon	0.0005	1.5	0.0005	0.75	0.0005	1.5	0.0005	1.5
Sn	Tin	0.0005	0.15					0.0005	0.15
Ta	Tantalum	0.005	4.5			0.02	4	0.006	0.15
Ti	Titanium	0.0005	0.5	0.0005	0.5	0.0005	0.2	0.0005	0.5
V	Vanadium	0.0005	0.025	0.0005	0.025	0.0005	0.02		
W	Tungsten	0.0005	18	0.0005	1	3	16	0.002	13
Zr	Zirconium	0.002	0.5			0.001	0.5		

Sub-programs &
Calibration Range Co Base

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Sub-programs & Calibration Ranges

		Cu_000		Cu_050		Cu_100		Cu_200		Cu_300		Cu_350		Cu_400		Cu_450		Cu_500	
		Orientation		Pure Copper		Be/Co/Ag Alloy		Cu-Zn Brass		Cu-Sn-Pb Bronze		Gunmetal		Cu-Ni Alloy		Cu-Ni-Zn Alloy		Cu-Al Alloy	
		Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
Ag	Silver	0.0005	5	0.0002	1.2	0.0005	15	0.0005	0.5	0.0005	1.2	0.0005	1.2	0.0002	0.5	0.0002	0.2		
Al	Aluminum	0.001	12	0.0002	0.25	0.0002	0.1	0.0005	4	0.0005	1	0.0005	1	0.0004	1.7	0.0002	0.3	0.0004	13
As	Arsenic	0.001	2	0.0001	0.5			0.0002	0.5	0.0005	1.8	0.0005	1.8					0.0002	0.5
Au	Gold			0.0002	0.015														
B	Boron	0.0001	0.05	0.0001	0.1									0.0001	0.1				
Be	Beryllium	0.0005	2.2	0.0001	1	0.0005	2.5							0.0001	0.2				
Bi	Bismuth	0.001	7	0.0001	0.1			0.001	7	0.0005	7	0.0005	1	0.0005	0.4				
C	Carbon													0.0002	0.1				
Cd	Cadmium	0.0005	1.2	0.0001	1.3			0.0005	0.6	0.0005	0.5	0.0005	0.5	0.001	0.5				
Co	Cobalt	0.001	3.6	0.0003	1	0.0005	3.6	0.0005	0.5	0.0005	0.75	0.0005	0.75	0.0005	0.2	0.0005	0.5		
Cr	Chromium	0.0005	3.2	0.0002	1.5	0.0005	0.1	0.0002	0.5	0.0002	0.1	0.0002	0.1	0.0002	3.2			0.0005	0.5
Fe	Iron	0.0005	7	0.0003	0.5	0.0005	0.5	0.0003	2	0.0003	2.5	0.0003	1	0.0003	3	0.0003	0.5	0.0003	8
Mg	Magnesium	0.0001	0.2	0.0001	0.1			0.0001	0.05					0.0001	0.1			0.0001	0.25
Mn	Manganese	0.0005	22	0.0001	0.2	0.0005	0.1	0.0003	20	0.0002	2.5	0.0002	1	0.0001	5	0.0001	1	0.0001	7
Nb	Niobium													0.0005	1				
Ni	Nickel	0.001	40	0.0005	0.6	0.0005	0.6	0.001	5	0.0005	3.5	0.0005	3.5	5	42	3	20	0.001	8
O	Oxygen			0.001	0.05														
P	Phosphorous	0.0005	1.2	0.0002	0.3	0.0002	0.3	0.0002	0.25	0.0002	1.2	0.0002	1.2	0.0002	0.3	0.0002	0.15	0.0002	0.2
Pb	Lead	0.0002	24	0.0002	1	0.0002	0.75	0.002	5	0.0005	24	0.0005	24	0.0002	0.5	0.0002	1	0.0002	1
S	Sulphur	0.0005	0.5	0.0002	0.1	0.0002	0.1	0.0002	0.1	0.0002	0.2	0.0002	0.2	0.0002	0.2	0.0002	0.1	0.0002	0.5
Sb	Antimony	0.001	5	0.0005	0.4			0.001	0.8	0.001	4.5	0.001	1.2	0.001	0.5				
Se	Selenium	0.001	1.6	0.0001	0.4			0.0002	1.5	0.0002	1.6			0.001	0.5				
Si	Silicon	0.0005	4	0.0002	2	0.0005	1	0.0002	4	0.0005	8	0.0005	1	0.025	4	0.0005	1	0.0002	1
Sn	Tin	0.0005	20	0.0001	0.5	0.0001	0.5	0.0001	11	0.0001	18	0.0001	18	0.0005	0.5	0.0001	0.5	0.0001	0.5
Te	Tellurium	0.002	1	0.0005	1														
Ti	Titanium	0.0002	0.08											0.0002	0.1				
Zn	Zinc	0.001	50	0.0002	0.5	0.0005	0.5	0.0005	50	0.0002	15	0.0002	15	0.0002	1.5	15	45	0.0002	1
Zr	Zirconium	0.0005	0.2	0.0002	0.2									0.0001	0.2				

Sub-programs &
Calibration Range Cu Base

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Sub-programs & Calibration Ranges

		Fe_000		Fe_100		Fe_150		Fe_200		Fe_250		Fe_300		Fe_400		Fe_500	
		Orientation		Low Alloy		Free Cutting Steel		Cast Steel		Cr Hard & Ni Resist		Stainless Steel		Toolsteel		Mn Steel	
		OE750	Max	OE750	Max	OE750	Max	OE750	Max	OE750	Max	OE750	Max	OE750	Max	OE750	Max
Al	Aluminum	0.001	6	0.0005	1.6	0.0005	1.6	0.0002	1.6	0.0005	0.3	0.0005	6	0.0005	0.5	0.0005	0.6
As	Arsenic			0.0005	0.15	0.0005	0.15	0.0001	0.15					0.0005	0.15		
B	Boron			0.0001	0.15	0.0001	0.15	0.0001	0.15	0.0001	0.1	0.0001	0.1				
Bi	Bismuth			0.0005	0.15	0.0005	0.15	0.0005	0.15								
C	Carbon	0.001	5.5	0.0005	1.8	0.0005	1.8	1	5	1	5	0.0005	2.5	0.001	3	0.0005	2
Ca	Calcium			0.0001	0.008							0.0001	0.008				
Ce	Cerium							0.001	0.2								
Co	Cobalt	0.0005	14	0.0005	1.25	0.0005	1.25	0.0005	2	0.0005	0.35	0.0005	10	0.0005	14	0.0005	0.6
Cr	Chromium	0.0005	45	0.0005	6	0.0005	6	0.0005	3	0.0005	40	0.0005	40	0.0005	24	0.0005	6
Cu	Copper	0.0002	12	0.0002	1	0.0002	1	0.0002	3	0.0002	11	0.0002	5	0.0002	0.5	0.0002	1
La	Lanthanum							0.0002	0.1								
Mg	Magnesium							0.0001	0.15								
Mn	Manganese	0.0005	24	0.0005	3	0.0005	3	0.0005	2.5	0.0005	2.5	0.0005	18	0.0005	1.5	5	24
Mo	Molybdenum	0.0005	12	0.0005	2	0.0005	2	0.0005	2	0.0005	4.5	0.0005	8	0.0005	12	0.0005	2.5
N	Nitrogen			0.001	0.8			0.001	0.5			0.001	1			0.001	0.8
Nb	Niobium	0.0005	3.5	0.0005	2	0.0005	2	0.0005	0.2	0.0005	0.5	0.0005	3.5	0.0005	1	0.0005	2
Ni	Nickel	0.0005	55	0.0005	6	0.0005	6	0.0005	4	0.0005	35	0.0005	55	0.0005	2	0.0005	4.5
P	Phosphorous	0.0005	0.2	0.0005	0.2	0.0005	0.2	0.0002	2	0.0005	0.25	0.0005	0.2	0.0005	0.2	0.0005	0.2
Pb	Lead	0.001	0.5	0.0005	0.15	0.0005	0.4	0.001	0.5			0.001	0.5			0.001	0.5
S	Sulfur	0.0005	0.2	0.0005	0.2	0.0005	0.4	0.0005	0.2	0.0005	0.2	0.0005	0.4	0.0005	0.2	0.0005	0.2
Sb	Antimony			0.0005	0.2	0.0005	0.2	0.0005	0.25			0.002	0.2				
Se	Selenium			0.001	0.25	0.001	0.25	0.001	0.25			0.0005	0.25				
Si	Silicon	0.001	5.5	0.0005	2.25	0.0005	2.25	0.0005	5.5	0.001	7	0.0005	2.5	0.0005	1.5	0.0005	2.5
Sn	Tin	0.0005	0.3	0.0005	0.3	0.0005	0.3	0.0005	0.3	0.0005	0.2	0.0005	0.3	0.0005	0.1	0.0005	0.3
Ta	Tantalum			0.005	0.3	0.005	0.3					0.005	0.2				
Te	Tellurium							0.0005	0.2								
Ti	Titanium	0.0002	1	0.0002	1	0.0002	1	0.0002	0.5	0.0002	0.5	0.0002	2	0.0002	0.25	0.0002	1.3
V	Vanadium	0.0005	12	0.0005	1	0.0005	1	0.0002	1	0.0005	1	0.0005	2	0.0002	12	0.0005	0.5
W	Tungsten	0.002	24	0.002	2	0.002	2	0.003	0.2	0.002	0.5	0.003	4	0.002	24	0.003	1.5
Zn	Zinc			0.0002	0.05	0.0002	0.05	0.0002	0.05								
Zr	Zirconium			0.0005	0.5	0.0005	0.5	0.0005	0.2			0.0005	0.5				

Sub-programs &
Calibration Range Fe Base

Sub-programs & Calibration Ranges

		Mg_000 Orientation		Mg_100 Low Alloy		Mg_200 Mg-Al/Mn/Zn Alloy		Mg_300 Mg-Ag/Rare Earths	
		Min	Max	Min	Max	Min	Max	Min	Max
Ag	Silver	0.0005	3	0.0001	0.3	0.0001	1	0.0005	3
Al	Aluminum	0.0015	13	0.001	0.5	0.001	15	0.0015	2
Be	Beryllium	0.0001	0.006	0.0001	0.006				
Ca	Calcium	0.0001	0.5	0.0001	0.25	0.0001	0.5	0.0001	0.5
Cd	Cadmium	0.0001	0.1	0.0001	0.05	0.0001	0.1		
Ce	Cerium	0.001	1	0.001	0.5	0.001	2	0.001	2
Cu	Copper	0.0005	3	0.0005	0.5	0.0003	3.2	0.0005	3
Er	Erbium	0.0015	0.25					0.0015	0.2
Fe	Iron	0.001	0.05	0.0005	0.05	0.0005	0.05	0.001	0.05
Gd	Gadolinium	0.001	2.2					0.001	2.2
La	Lanthanum	0.0005	1.5	0.0005	0.5	0.0005	1.5	0.0005	1.5
Mn	Manganese	0.0002	2.5	0.0001	0.5	0.0001	2.5	0.0002	2.5
Nd	Neodymium	0.005	3					0.005	3
Ni	Nickel	0.0005	0.02	0.0005	0.05	0.0005	0.05	0.0005	0.05
Pb	Lead	0.002	0.12	0.002	0.12	0.002	0.12	0.002	0.12
Pr	Praseodymium	0.008	0.85					0.008	1
Si	Silicon	0.0005	2	0.0005	0.5	0.0005	2	0.0005	2
Sn	Tin	0.0005	0.2	0.0005	0.2	0.0005	0.25	0.0005	0.2
Sr	Strontium	0.0001	1.2					0.0001	1.2
Tb	Terbium	0.0001	0.15					0.0001	0.15
Y	Yttrium	0.0001	5					0.0001	5
Yb	Ytterbium	0.0001	0.1					0.0001	0.15
Zn	Zinc	0.0001	7.2	0.0001	0.75	0.0001	7.2	0.0001	7.2
Zr	Zirconium	0.0005	0.6	0.0005	0.6	0.0005	0.6	0.0005	0.6

Sub-programs &
Calibration Range Mg Base

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Sub-programs & Calibration Ranges

		Ni_000 Orientation		Ni_100 Low Alloy		Ni_200 Monel		Ni_300 Nimonic/Waspaloy		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	0.0005	8	0.0005	0.5	0.0005	5	0.001	8	0.0005	2	0.0005	8	0.0005	4	0.5	8
B	Boron	0.0005	3.5					0.0001	0.25	0.0002	0.5	0.0002	0.5	0.0002	1	0.0001	0.5
C	Carbon	0.0005	1	0.0005	0.5	0.0005	0.1	0.0005	0.3	0.0005	0.5	0.0005	0.5	0.0005	1	0.0005	0.5
Co	Cobalt	0.001	25	0.0005	1.2	0.001	1.2	7.5	23	0.001	4	0.001	22	0.001	5	2	22
Cr	Chromium	0.0005	40	0.0002	0.5	0.0002	1	0.25	35	0.0002	40	10	35	0.0002	30	2	30
Cu	Copper	0.0002	40	0.0002	0.5	22	35	0.0002	1	0.0002	2.5	0.0002	4	0.0002	2	0.0002	1
Fe	Iron	0.0005	55	0.0005	0.5	0.0005	3.5	0.0005	2.5	25	45	0.0005	32	0.0005	20	0.0005	1.5
Hf	Hafnium	0.0005	2													0.0005	2.2
Mg	Magnesium	0.0001	0.25	0.0001	0.25	0.0001	0.25	0.0001	0.25	0.0001	0.25	0.0001	0.25	0.0001	0.25	0.0001	0.25
Mn	Manganese	0.0005	3.5	0.0005	0.5	0.0002	3.2	0.0002	1	0.0005	2	0.0005	2	0.0005	2	0.0005	1
Mo	Molybdenium	0.001	40					0.0005	12	0.0002	10	0.0002	12	5	40	0.0005	6
N	Nitrogen											0.002	0.5	0.002	0.5		
Nb	Niobium	0.001	8			0.001	1	0.001	0.5	0.001	1	0.001	8	0.001	5	0.001	1
P	Phosphorous					0.0002	0.1	0.0002	0.1	0.0002	0.1	0.0002	0.1	0.0002	0.1	0.0002	0.1
Pb	Lead					0.0005	0.1										
S	Sulphur			0.0002	0.15	0.0005	0.1	0.0005	0.15	0.0005	0.15	0.0005	0.15	0.0005	0.1		
Si	Silicon	0.0005	8	0.0005	1	0.0005	5.5	0.0005	1.2	0.0005	3	0.0005	3	0.0005	8	0.0005	1
Sn	Tin	0.0002	1			0.0002	1	0.0002	1								
Ta	Tantalum	0.001	7					0.0005	5							0.001	8
Ti	Titanium	0.001	8	0.0005	0.5	0.0005	1.8	0.0005	6	0.0005	3	0.0005	7	0.0005	1	0.0005	5
V	Vanadium	0.0005	1.25					0.0002	1.25	0.0002	1.25	0.0002	1.25	0.0005	1.25	0.0005	1.25
W	Tungsten	0.002	13					0.002	4	0.002	6	0.002	5	0.002	7	0.002	13.5
Zr	Zirconium	0.001	0.5					0.0005	0.5	0.001	0.2	0.001	0.2			0.001	0.5

Sub-programs & Calibration Range Ni Base

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Sub-programs & Calibration Ranges

		Pb_000 Orientation		Pb_100 Low Alloy		Pb_200 Pb-Ag Alloy		Pb_300 Pb-Sb Alloy		Pb_400 Pb-Sn Alloy	
		Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
Ag	Silver	0.0001	3.5	0.0001	0.55	0.0001	3.5	0.0001	0.5	0.0001	0.5
Al	Aluminum	0.0001	0.05	0.0001	0.05					0.0001	0.05
As	Arsenic	0.0001	6.5	0.0001	0.15	0.0001	0.8	0.0001	1.7	0.0001	0.15
Au	Gold	0.0001	0.13	0.0001	0.015					0.0001	0.13
Bi	Bismuth	0.0001	3.5	0.0001	1	0.0001	1.2	0.0001	0.5	0.0001	1.25
Ca	Calcium	0.0001	0.5	0.0001	0.5	0.0001	0.25				
Cd	Cadmium	0.0001	0.6	0.0001	0.5	0.0001	0.6	0.0001	0.6	0.0001	0.25
Cu	Copper	0.0001	0.75	0.0001	0.3	0.0001	0.75	0.0001	0.75	0.0001	0.3
Fe	Iron	0.0001	0.03	0.0001	0.03					0.0001	0.03
Hg	Mercury	0.0001	0.1	0.0001	0.1						
In	Indium	0.0001	0.75	0.0001	0.75			0.0001	0.4	0.0001	0.35
Na	Sodium	0.0001	0.02	0.0001	0.02						
Ni	Nickel	0.0001	0.02	0.0001	0.02			0.0001	0.02	0.0001	0.02
Pd	Palladium	0.0001	0.01					0.0001	0.01		
S	Sulfur	0.0005	0.025							0.0005	0.025
Sb	Antimony	0.0001	16	0.0001	1	0.0001	1.2	0.0001	17	0.0001	3.5
Se	Selenium	0.0003	0.06					0.0003	0.05		
Sn	Tin	0.0001	65	0.0001	1	0.0001	1.1	0.0001	11	0.1	65
Te	Tellurium	0.0001	0.05	0.0001	0.05			0.0001	0.05		
Tl	Thallium	0.0001	0.075	0.0001	0.075					0.0001	0.075
Zn	Zinc	0.0001	0.12	0.0001	0.05	0.0001	0.05	0.0001	0.125	0.0001	0.125

Sub-programs &
Calibration Range Pb Base

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Sub-programs & Calibration Ranges

		Sn_000		Sn_100		Sn_200		Sn_300		Sn_400	
		Orientation		Sn-Pure Alloy		Sn-Sb-Cu Alloy		Sn-Ag Alloy		Sn-Pb Alloy	
		Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
Ag	Silver	0.0001	5	0.0001	0.1	0.0001	2.3	0.0001	5	0.0001	2.3
Al	Aluminum	0.0001	0.1	0.0001	0.1	0.0001	0.1	0.0001	0.1	0.0001	0.1
As	Arsenic	0.001	1	0.001	0.15	0.001	0.6	0.001	1	0.001	1
Au	Gold	0.0001	0.1	0.0001	0.02						
Bi	Bismuth	0.0001	3.2	0.0001	0.25	0.0001	3.2	0.0001	3.2	0.0001	3.2
Cd	Cadmium	0.0001	2	0.0001	0.12	0.0001	2	0.0001	2	0.0001	2
Co	Cobalt	0.0001	0.05			0.0001	0.05	0.0001	0.05	0.0001	0.02
Cu	Copper	0.0002	12	0.0002	0.75	0.0002	12	0.0002	2	0.0002	3
Fe	Iron	0.0001	0.15	0.0001	0.04	0.0001	0.15	0.0001	0.15	0.0001	0.05
Ga	Gallium	0.0001	0.04	0.0001	0.04						
Ge	Germanium	0.0002	0.5	0.0002	0.5						
Hg	Mercury	0.001	0.2	0.001	0.2						
In	Indium	0.0001	0.25	0.0001	0.12	0.0001	0.12	0.0001	0.25	0.0001	0.12
Ni	Nickel	0.0001	1.5	0.0001	0.05	0.0001	1.5	0.0001	1.5	0.0001	0.3
P	Phosphorus	0.001	0.04							0.001	0.025
Pb	Lead	0.0001	50	0.0001	0.5	0.0001	3	0.0001	2	0.0001	50
S	Sulfur	0.0005	0.025			0.0005	0.025	0.0005	0.025	0.0005	0.025
Sb	Antimony	0.0002	17	0.0002	0.15	0.0002	17	0.0002	1.5	0.0002	3.5
Se	Selenium	0.0002	0.075	0.0002	0.01	0.0002	0.01	0.0002	0.075	0.0002	0.05
Te	Tellurium	0.0002	0.1	0.0002	0.1						
Zn	Zinc	0.0001	10	0.0001	0.1	0.0001	10	0.0001	10	0.0001	10

Sub-programs &
Calibration Range Sn Base

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Sub-programs & Calibration Ranges

		Ti_000 Orientation		Ti_100 Pure Ti		Ti_200 Ti-Al/Sn/Zr/Mo		Ti_300 Ti-Al/V Alloy		Ti_400 Gases in Ti	
		Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
Al	Aluminum	0.0005	9	0.0005	0.4	0.0005	9	0.0005	8	0.0005	9
C	Carbon	0.0005	0.12	0.0002	0.035	0.0005	0.12	0.0005	0.12	0.0005	0.15
Cr	Chromium	0.002	7.5	0.002	0.015	0.002	7.5	0.002	7.5	0.002	7.5
Cu	Copper	0.001	3	0.001	0.012	0.001	3	0.001	0.6	0.001	3
Fe	Iron	0.0001	2.2	0.0005	0.3	0.0001	2.2	0.0001	2.2	0.0001	2.2
H	Hydrogen									0.0005	0.015
Mn	Manganese	0.0005	8			0.0005	8	0.0005	4.8	0.0005	8
Mo	Molybdenum	0.0005	7.5	0.0005	0.3	0.0005	7.5	0.0005	4.2	0.0005	7.5
N	Nitrogen									0.0015	0.03
Nb	Niobium	0.0002	8	0.002	0.07	0.0002	8	0.0001	7	0.0002	8
Ni	Nickel	0.0005	1	0.0002	0.9	0.0005	1	0.0002	1	0.0005	1
O	Oxygen									0.01	0.4
Pd	Palladium	0.003	0.2	0.003	0.2	0.003	0.2	0.003	0.2	0.003	0.2
Ru	Ruthenium	0.001	0.2	0.001	0.2	0.001	0.2	0.001	0.2	0.001	0.2
Si	Silicon	0.001	1	0.001	0.02	0.001	1	0.0015	0.5	0.001	1
Sn	Tin	0.0005	12	0.0005	1	0.0005	12	0.0005	3	0.0005	12
Ta	Tantalum	0.003	1.2			0.003	1.2	0.003	1.2	0.003	1.2
V	Vanadium	0.001	18	0.001	0.5	0.001	18	0.001	18	0.001	18
W	Tungsten	0.003	1.2			0.003	1.2	0.003	1	0.003	1.2
Zr	Zirconium	0.001	5	0.001	0.012	0.001	5	0.001	4	0.001	5

Sub-programs &
Calibration Range Ti Base

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Sub-programs & Calibration Ranges

		Zn_000		Zn_040		Zn_100		Zn_300		Zn_350		Zn_500	
		Orientation		Al 2-6% Cu 0-3,5%		Al 7-15% Cu 0-6%		Al 15-35% Cu 0-6%		Al 15-35% Sb 0-15%		Remelt	
		Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
Ag	Silver											0.0003	0.15
Al	Aluminum	0.001	40	1.5	6	6	16	15	35	5	35	0.0005	1.5
As	Arsenic											0.0003	0.003
Bi	Bismuth			0.0005	0.2	0.0005	0.2			0.0005	0.2	0.0005	0.2
Cd	Cadmium	0.0002	0.25	0.0002	0.25	0.0002	0.25	0.0002	0.25	0.0002	0.25	0.0002	0.8
Ce	Cerium			0.0002	0.05								
Cr	Chromium			0.0002	0.2	0.0002	0.2	0.0002	0.2			0.0002	0.25
Cu	Copper	0.0005	7	0.0005	5.25	0.0005	7	0.0005	7	0.0005	0.5	0.0005	2.5
Fe	Iron			0.0005	0.6	0.0005	0.6	0.0005	0.6	0.0005	0.6	0.001	0.75
Hg	Mercury											0.0001	0.005
In	Indium			0.0005	0.05							0.0005	0.5
La	Lanthanum			0.0002	0.05								
Mg	Magnesium	0.0001	0.25	0.0001	0.525	0.0001	0.25	0.0001	0.25	0.0001	0.25	0.0001	0.25
Mn	Manganese			0.0001	0.12	0.0001	0.12	0.0001	0.12			0.0001	0.05
Ni	Nickel			0.0004	0.1	0.0004	0.1	0.0004	0.1			0.0004	0.15
Pb	Lead	0.0005	2.5	0.0005	0.5	0.0005	0.5	0.0005	0.5	0.0005	0.5	0.0004	2.5
Sb	Antimony	0.001	12	0.001	0.3	0.002	0.3	0.001	0.3	0.001	12	0.001	0.3
Si	Silicon			0.0002	0.025	0.0002	0.025	0.0002	0.025				
Sn	Tin	0.0005	1	0.0005	0.5	0.0005	0.5	0.0005	0.5	0.0005	0.5	0.0005	2
Ti	Titanium			0.0001	0.5	0.0001	0.5	0.0001	0.5			0.0001	0.5
Tl	Thallium			0.0001	0.02							0.0001	0.04

Sub-programs & Calibration Range Zn Base

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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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