



## PMI-MASTER Smart

### Portable OES laboratory

The PMI-MASTER Smart is the ideal solution for metals analysis at low detection limits in a safety critical environment and in hard-to-reach places. This compact and light weight spark spectrometer can be carried to the point of analysis and offers higher analytical performance where handheld XRF and LIBS analyzers reach their limits.

The PMI-MASTER Smart meets the world's most stringent PMI metallurgical alloy chemistry testing requirements including API 5L, ASME section IX B& PV, ISO 17025 and A2LA standards.

### Highlights and applications

- | Analyses most metals and their alloys, including carbon, phosphorus, sulfur, boron, arsenic and tin in low alloy and stainless steels, and nitrogen in duplex steels
- | High analytical performance from powerful patented high-resolution carbon fiber Multi-CCD optics
- | Wavelength range: 186 – 671 nm / UVTouch 165 – 671 nm
- | Easy to carry with compact design and weighing just 15 kg
- | Cordless operation with rechargeable battery pack
- | Preinstalled GRADE Database for fast and easy grade identification
- | Advanced data management with cloud-based ExTOPE Connect
- | Tailored to your specific application with three different probe options
- | Hot sample measurements up to 300° C / 572° F



## Sub-programs &amp; Calibration Ranges

**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.

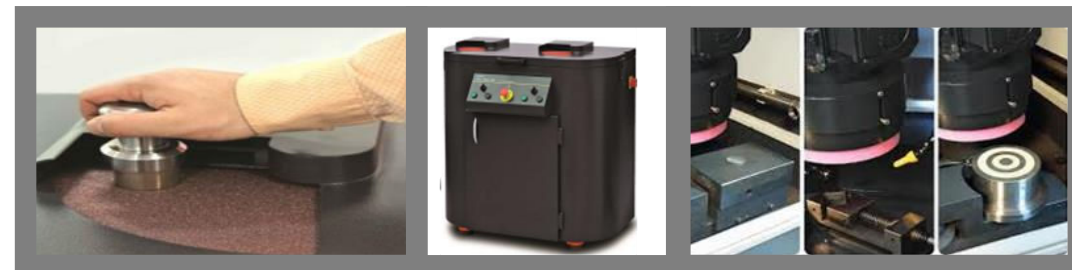
**SAMPLE PREPARATION FOR Co, Fe, Ni**

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.



## Sub-programs &amp; Calibration Ranges

## DIFFERENCE BETWEEN LOD AND LOQ

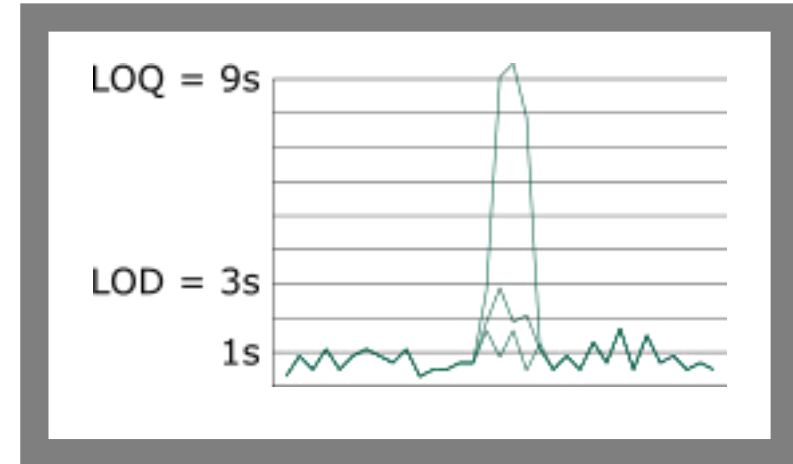
The BEC (equivalent concentration of spectral background) value is the concentration of the analysis sample required to produce the same intensity signal as the background at a given wavelength. The BEC is obtained from the calibration curve and is a fundamental process variable as it directly affects 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 ( $1\sigma$ ).

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.



### Sub-programs & Calibration Range AI Base

Spark Probe

		AI_000	
		Global	
		Min	Max
Ag	Silver	0.001	1.1
B	Boron	0.001	0.025
Be	Beryllium	0.0005	0.025
Bi	Bismuth	0.0075	0.75
Ca	Calcium	0.0005	0.025
Cd	Cadmium	0.001	0.4
Ce	Cerium	0.005	0.05
Co	Cobalt	0.002	0.5
Cr	Chromium	0.001	1
Cu	Copper	0.001	11
Fe	Iron	0.002	3
Ga	Gallium	0.002	0.12
Hg	Mercury	0.003	0.1
In	Indium	0.005	0.1
La	Lanthanum	0.002	0.035
Li	Lithium	0.0005	0.025
Mg	Magnesium	0.0005	12
Mn	Manganese	0.001	2
Mo	Molybdenum	0.003	0.9
Na	Sodium	0.001	0.02
Ni	Nickel	0.003	5.5
Pb	Lead	0.005	1.75
Sc	Scandium	0.0005	0.05
Si	Silicon	0.002	25
Sn	Tin	0.005	4.4
Sr	Strontium	0.0005	0.15
Ti	Titanium	0.001	0.7
V	Vanadium	0.001	0.15
Zn	Zinc	0.005	13
Zr	Zirconium	0.001	1

## Sub-programs &amp; Calibration Ranges

## Sub-programs &amp; Calibration Range Co Base

Spark Probe

		Co_000	
		Global	
		Min	Max
Al	Aluminium	0.003	1.5
C	Carbon	0.015	2.6
Cr	Chromium	10	40
Cu	Copper	0.003	0.2
Fe	Iron	0.005	20
Mn	Manganese	0.005	2.2
Mo	Molybdenum	0.005	10
Nb	Niobium	0.005	2.8
Ni	Nickel	0.015	25
Si	Silicon	0.005	1.8
Sn	Tin	0.01	0.15
Ta	Tantalum	0.02	0.16
Ti	Titanium	0.003	0.5
W	Tungsten	0.05	20

## Sub-programs & Calibration Ranges

### Sub-programs & Calibration Range Cu Base

#### UVTouch Probe

		Cu_T_000		Cu_T_050	
		Global		Pure Copper UVT	
		Min	Max	Min	Max
Ag	Silver	0.0005	5	0.0005	5
Al	Aluminum	0.015	11	0.015	0.06
As	Arsenic	0.004	0.5	0.001	0.35
B	Boron	0.001	0.035	0.001	0.035
Be	Beryllium	0.0005	2	0.0005	2
Bi	Bismuth	0.002	0.7	0.002	0.05
Cd	Cadmium	0.0005	1.1	0.0005	1.1
Co	Cobalt	0.003	3	0.003	0.5
Cr	Chromium	0.0005	2.7	0.0005	0.1
Fe	Iron	0.0025	6.1	0.0025	0.2
Mg	Magnesium	0.0005	0.18	0.0005	0.025
Mn	Manganese	0.0005	18.5	0.0005	0.15
Ni	Nickel	0.001	33	0.001	0.5
P	Phosphorus	0.0025	1	0.0025	0.1
Pb	Lead	0.002	20	0.002	1
S	Sulfur	0.0015	0.15	0.0015	0.06
Sb	Antimony	0.025	1	0.025	0.35
Se	Selenium	0.003	1.3	0.003	0.07
Si	Silicon	0.002	7.1	0.002	0.2
Sn	Tin	0.001	16.5	0.001	0.5
Ti	Titanium	0.002	0.06		
Zn	Zinc	0.001	42	0.001	0.5
Zr	Zirconium	0.0005	0.05	0.0005	0.06

#### Spark Probe

		Cu_000	
		Global	
		Min	Max
Ag	Silver	0.002	2
Al	Aluminium	0.002	12.5
Be	Beryllium	0.0005	4
Bi	Bismuth	0.025	7
Cd	Cadmium	0.001	1.3
Co	Cobalt	0.003	3.5
Cr	Chromium	0.002	3.5
Fe	Iron	0.005	7
Mg	Magnesium	0.0005	0.25
Mn	Manganese	0.002	14
Ni	Nickel	0.003	37
Pb	Lead	0.025	22
Se	Selenium	0.02	1
Si	Silicon	0.003	8
Sn	Tin	0.01	18
Ti	Titanium	0.001	0.07
Zn	Zinc	0.01	50
Zr	Zirconium	0.002	0.15

## Sub-programs & Calibration Ranges

### Sub-programs & Calibration Range Fe Base

UVTouch Probe

		Fe_T_000		Fe_T_100		Fe_T_150		Fe_T_200		Fe_T_250		Fe_T_300		Fe_T_305		Fe_T_400		Fe_T_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	0.0025	1.5	0.002	1.5	0.002	1.5	0.002	0.1	0.0025	0.5	0.0025	6	0.0025	6	0.003	0.4	0.003	0.4
As	Arsenic			0.015	0.125	0.015	0.125	0.008	0.1										
B	Boron			0.001	0.025	0.001	0.025	0.001	0.1			0.001	0.018	0.001	0.018				
Bi	Bismuth			0.001	0.11	0.001	0.126												
C	Carbon	0.011	4.5	0.003	1.7	0.003	1.7	1	4.5	1	4	0.003	2.5	0.003	2.5	0.003	3	0.003	1.7
Ca	Calcium			0.0005	0.007														
Co	Cobalt	0.0015	12	0.0015	1	0.0015	1	0.0015	0.25	0.0015	2	0.0015	12	0.0015	12	0.0015	11	0.0015	1
Cr	Chromium	0.002	35	0.002	5.5	0.002	5.5	0.002	2	0.002	34	0.002	35	0.002	35	0.002	32	0.002	5
Cu	Copper	0.001	9	0.001	1.2	0.001	1.2	0.001	2.7	0.001	9	0.001	6	0.001	6	0.001	1	0.001	0.7
Mg	Magnesium							0.0005	0.09										
Mn	Manganese	0.0015	22	0.0015	2.5	0.0015	2.5	0.0015	1.3	0.0015	2	0.0015	20	0.0015	15	0.0015	2.5	7	22
Mo	Molybdenum	0.002	10	0.002	1.6	0.003	1.6	0.002	1.5	0.002	3.5	0.0025	6	0.0025	6	0.0025	10	0.005	2
N	Nitrogen												0.1	1.2					
Nb	Niobium	0.005	3	0.002	1	0.002	1	0.005	0.15	0.002	3	0.005	3.5	0.005	3.5	0.005	1.5	0.005	1.5
Ni	Nickel	0.004	52	0.004	5.5	0.004	5.5	0.004	4.3	0.004	30	0.0045	55	0.0045	55	0.004	5.5	0.004	4
P	Phosphorus			0.002	0.17	0.002	0.17	0.003	0.7	0.003	0.4	0.003	0.15	0.003	0.15	0.002	0.1	0.003	0.1
Pb	Lead	0.008	0.35	0.008	0.15	0.008	0.35	0.008	0.23			0.01	0.3	0.015	0.3				
S	Sulfur			0.002	0.1	0.002	0.45	0.002	0.2	0.002	0.3	0.002	0.4	0.002	0.4	0.002	0.1	0.002	0.1
Si	Silicon	0.005	6	0.005	2.5	0.005	2.5	0.005	4	0.005	6	0.005	3.2	0.005	3.2	0.005	2	0.005	2.5
Sn	Tin			0.002	0.3	0.003	0.3	0.002	0.2			0.002	0.25	0.002	0.25	0.003	0.3		
Ti	Titanium	0.0005	1.5	0.0005	0.6	0.0005	0.6	0.0005	0.2	0.0005	0.4	0.0005	1.5	0.0005	1.5	0.0005	0.3	0.0005	1
V	Vanadium	0.001	10	0.001	1	0.001	1	0.001	0.7	0.001	0.8	0.001	1	0.001	1	0.001	10	0.001	1
W	Tungsten	0.015	21	0.035	2.5	0.035	2.5					0.03	3.5	0.03	3.5	0.015	21		
Zr	Zirconium			0.0015	0.5	0.0015	0.5	0.0015	0.05			0.0015	0.4	0.0015	0.4				

## Sub-programs & Calibration Ranges

### Sub-programs & Calibration Range Fe Base

Spark Probe

		Fe_000		Fe_100		Fe_200		Fe_250		Fe_300		Fe_400		Fe_500	
		Orientation		Low alloy		Cast Steel		Cr-Hard & Ni Resist		Stainless Steel + N		Tool Steel		Mn Steel	
		Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
Al	Aluminum	0.003	1.5	0.002	1.5	0.004	0.125	0.003	0.5	0.003	1.2	0.003	0.4	0.004	0.4
C	Carbon	0.025	4.5	0.02	1.7	1	4.5	1	4.5	0.02	2.5	0.02	3	0.02	1.7
Co	Cobalt	0.005	12	0.002	1	0.004	0.3	0.005	1	0.002	13	0.004	12	0.004	1
Cr	Chromium	0.005	35	0.003	5.5	0.005	2.5	0.005	35	0.005	35	0.0022	30	0.005	4
Cu	Copper	0.002	9	0.002	1.2	0.002	3.5	0.002	10	0.001	8	0.004	1	0.004	0.5
Mg	Magnesium					0.0005	0.1								
Mn	Manganese	0.005	22	0.002	2.5	0.004	1.6	0.003	2.5	0.002	20	0.004	2.5	7	22
Mo	Molybdenum	0.005	12	0.005	2	0.005	2	0.005	4	0.003	8	0.005	11	0.005	2.25
Nb	Niobium	0.003	2	0.002	1	0.005	0.2	0.003	3.5	0.005	3.5	0.004	1	0.005	1.5
Ni	Nickel	0.005	55	0.005	5.5	0.005	3.5	0.005	30	0.005	55	0.005	5	0.005	5
Pb	Lead	0.015	0.4	0.015	0.35	0.015	0.4			0.015	0.4				
Si	Silicon	0.005	7	0.005	2.5	0.005	4	0.005	7	0.005	4	0.005	2.5	0.005	2.5
Ti	Titanium	0.003	2	0.001	0.6	0.003	0.35	0.003	0.5	0.005	2.5	0.004	0.5	0.004	1.25
V	Vanadium	0.005	12	0.001	1	0.004	0.8	0.005	1	0.003	1	0.005	11.5	0.004	1
W	Tungsten	0.05	24	0.04	2.5					0.05	4	0.05	22		
Zr	Zirconium			0.002	0.5	0.005	0.1								



## Sub-programs & Calibration Ranges

### Sub-programs & Calibration Range Ni Base

UVTouch Probe

		Ni_T_000		Ni_T_100		Ni_T_200		Ni_T_300		Ni_T_400		Ni_T_500		Ni_T_600		Ni_T_700	
		Global		Low Alloy		Monel		Nimonic/Waspalloy		Incoloy		Inconel		Hastelloy		Marmalloy	
		Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
<b>Al</b>	Aluminum	0.006	7	0.006	0.2	0.006	4	0.006	7	0.006	7	0.006	2	0.006	0.45	1	7
<b>B</b>	Boron	0.0005	3					0.0005	0.03			0.0005	0.3	0.0005	3	0.0005	0.03
<b>C</b>	Carbon	0.002	0.5	0.002	0.08	0.002	0.18	0.002	0.3	0.003	0.35	0.003	0.2	0.005	0.5	0.003	0.35
<b>Co</b>	Cobalt	0.005	20	0.002	1	0.005	1	1	20	0.002	22	0.002	20	0.0025	3	0.002	21
<b>Cr</b>	Chromium	0.0025	30	0.0025	0.25	0.0025	0.35	10	22	10	25	10	30	0.003	25	1	25
<b>Cu</b>	Copper	0.001	35	0.001	0.25	15	35	0.001	0.8	0.001	2.5	0.001	0.5	0.001	0.2	0.001	0.31
<b>Fe</b>	Iron	0.003	50	0.003	0.6	0.003	3.5	0.003	2.5	20	50	0.003	25	0.003	22	0.003	1.5
<b>Hf</b>	Hafnium	0.005	2													0.001	2
<b>Mg</b>	Magnesium	0.0005	0.15			0.0005	0.15	0.0005	0.05	0.0005	0.04					0.0005	0.04
<b>Mn</b>	Manganese	0.0015	3	0.001	0.5	0.001	3.2	0.001	0.6	0.0015	1.6	0.001	0.7	0.001	1.5	0.0015	0.5
<b>Mo</b>	Molybdenium	0.009	35			0.002	2	0.002	12	0.005	10	0.009	12	0.009	35	0.008	7
<b>Nb</b>	Niobium	0.002	7.5	0.002	1			0.002	0.3	0.002	7	0.002	7	0.003	3	0.002	3.3
<b>P</b>	Phosphorus	0.003	0.06			0.003	0.06	0.002	0.02	0.002	0.05			0.002	0.06		
<b>Pb</b>	Lead	0.003	0.07														
<b>S</b>	Sulfur	0.004	0.06			0.004	0.06	0.004	0.03	0.005	0.1	0.001	0.07	0.0025	0.05	0.002	0.03
<b>Si</b>	Silicon	0.0045	7	0.004	0.4	0.0045	7	0.003	1.2	0.004	3	0.0045	1.5	0.004	7	0.004	0.4
<b>Sn</b>	Tin	0.0005	0.7					0.0005	0.07					0.001	0.7		
<b>Ta</b>	Tantalum	0.006	7					0.006	4							0.0035	7
<b>Ti</b>	Titanium	0.001	5.5	0.001	0.35	0.001	1.5	0.001	6	0.0015	3	0.001	3	0.001	0.35	0.0015	4
<b>V</b>	Vanadium	0.0015	1					0.0015	1	0.001	1	0.001	0.8	0.002	1	0.001	0.5
<b>W</b>	Tungsten	0.05	12			0.05	1.2	0.05	0.3	0.05	4	0.05	3.5	0.05	12	0.05	12
<b>Zr</b>	Zirconium	0.0005	0.3					0.0005	0.3	0.0005	0.18					0.0005	0.3

## Sub-programs & Calibration Ranges

### Sub-programs & Calibration Range Ni Base

#### Spark Probe

		Ni_000		Ni_100		Ni_200		Ni_300		Ni_400		Ni_500		Ni_600		Ni_700	
		Global		Low Alloy		Monel		Nimonic/Waspalloy		Incoloy		Inconel		Hastelloy		Marmalloy	
		Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
Al	Aluminum	0.002	8	0.002	0.2	0.002	4	0.002	7	0.002	7	0.002	2	0.002	0.45	1	7
B	Boron	0.002	3									0.005	0.03	0.015	3		
C	Carbon			0.004	0.08	0.005	0.15					0.025	0.2	0.15	0.5	0.005	0.35
Co	Cobalt	0.006	35	0.001	1	0.001	1	1	22	0.002	22	0.002	21	0.002	3	0.001	22
Cr	Chromium	0.005	36	0.002	0.25	0.003	0.35	10	22	10	25	10	33	0.002	25	1	25
Cu	Copper	0.0005	35	0.002	0.25	15	35	0.001	1	0.001	2.5	0.001	0.5	0.001	0.2	0.001	0.33
Fe	Iron	0.005	50	0.0025	0.6	0.003	3.5	0.002	2.5	20	50	0.003	25	0.002	22	0.002	1.5
Hf	Hafnium	0.005	2													0.005	2
Mg	Magnesium	0.001	0.15			0.001	0.2	0.0001	0.05	0.0001	0.04					0.0001	0.04
Mn	Manganese	0.001	3	0.0008	0.5	0.0005	3.2	0.001	0.6	0.001	1.6	0.001	0.7	0.001	1.5	0.001	0.5
Mo	Molybdenum	0.001	40					0.002	12	0.003	10	0.003	12	0.002	35	0.002	7
Nb	Niobium	0.001	8	0.002	1			0.005	0.3	0.002	7	0.002	7	0.001	3	0.002	3.3
Pb	Lead	0.002	0.07														
Si	Silicon	0.003	7	0.003	0.42	0.005	7	0.002	1.2	0.003	3	0.002	1.5	0.003	7	0.003	0.4
Ta	Tantalum	0.025	7					0.015	4.5							0.006	7
Ti	Titanium	0.001	6	0.002	0.35	0.002	1.5	0.001	6	0.001	3	0.003	3	0.001	0.35	0.002	4
V	Vanadium	0.001	1					0.001	1	0.001	1	0.0005	0.8	0.001	1	0.001	0.5
W	Tungsten	0.025	15					0.025	0.3	0.015	4	0.05	3.5	0.05	15	0.035	13
Zr	Zirconium	0.002	0.3					0.002	0.3	0.001	0.18					0.002	0.3

## Sub-programs &amp; Calibration Ranges

## Sub-programs &amp; Calibration Range Sn Base

Spark Probe

		Sn_000	
		Global	
		Min	Max
Ag	Silver	0.003	4.5
Al	Aluminum	0.001	0.1
As	Arsenic	0.005	1
Au	Gold	0.001	0.12
Bi	Bismuth	0.003	1.5
Cd	Cadmium	0.001	2.1
Co	Cobalt	0.003	0.025
Cu	Copper	0.001	12
Fe	Iron	0.001	0.1
Ga	Mercury	0.001	0.05
Hg	Indium	0.001	0.175
In	Nickel	0.001	0.125
Ni	Phosphorous	0.001	1.5
Pb	Lead	0.005	50
Sb	Sulfur	0.005	20
Se	Antimony	0.002	0.015
Te	Sulfur	0.002	0.1
Zn	Antimony	0.001	3

### Sub-programs & Calibration Range Ti Base

Spark Probe

		Ti_000	
		Global	
		Min	Max
Al	Aluminum	0.01	9
Cr	Chromium	0.005	7
Cu	Copper	0.005	1.5
Fe	Iron	0.01	2.5
Mn	Manganese	0.01	8
Mo	Molybdenum	0.01	5
Nb	Niobium	0.01	8
Ni	Nickel	0.01	1
Pd	Palladium	0.015	0.18
Ru	Ruthenium	0.01	0.12
Si	Silicon	0.01	1
Sn	Tin	0.01	13
Ta	Tantalum	0.01	1.2
V	Vanadium	0.01	18
W	Tungsten	0.02	1.1
Zr	Zirconium	0.01	6

### Sub-programs & Calibration Range Zn Base

Spark Probe

		Zn_000	
		Global	
		Min	Max
<b>Al</b>	Aluminum	0.005	35
<b>Cd</b>	Cadmium	0.003	0.8
<b>Cu</b>	Copper	0.005	7
<b>Fe</b>	Iron	0.005	0.5
<b>Mg</b>	Magnesium	0.002	0.25
<b>Mn</b>	Manganese	0.001	0.12
<b>Ni</b>	Nickel	0.005	0.075
<b>Pb</b>	Lead	0.005	2.5
<b>Si</b>	Silicon	0.002	0.12
<b>Sn</b>	Tin	0.005	2.5
<b>Ti</b>	Titanium	0.002	0.02

## 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](#).

## Hitachi High-Tech Analytical Science

This publication is the copyright of Hitachi High-Tech Analytical Science Ltd and provides outline information only, which (unless agreed by the company in writing) may not be used, applied or reproduced for any purpose or form part of any order or contract or regarded as the representation relating to the products or services concerned. Hitachi High-Tech Analytical Science Ltd's policy is one of continued improvement. The company reserves the right to alter, without notice the specification, design or conditions of supply of any product or service.

Hitachi High-Tech Analytical Science Ltd acknowledges all trademarks and registrations.

© Hitachi High-Tech Analytical Science, 2022. All rights reserved.

