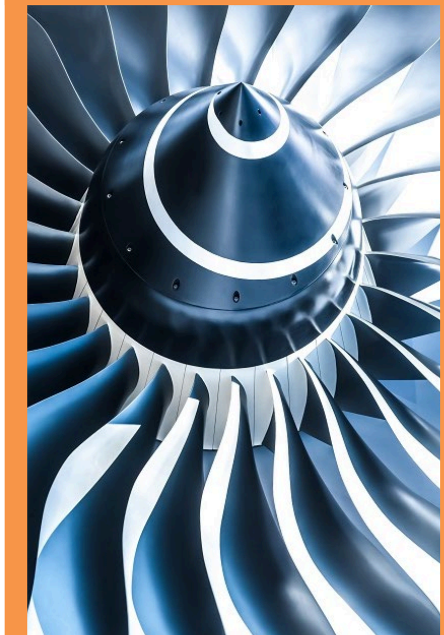
Determination of Titanium alloys



OE750 FOR HIGH-DEMAND TITANIUM ANALYSIS

BACKGROUND

The new 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.

The OE750 is designed to meet the exacting requirements of Titanium industries, especially those requiring lower detection limits for Silicon, Palladium and Ruthenium. It is also able to analyze gases such as Hydrogen, Oxygen and Nitrogen meeting requirements of typical Titanium grades where those elements are specified.

The OE750 comes with software that makes analysis faster, more accurate and easier to interpret. This offers results analysis that helps with process control, and 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 – 766 nm
- 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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APPLICATION OF TI ALLOYS

Titanium is a durable, light metal. More robust than standard low-carbon steels, but 45 % lighter, Titanium is also twice as strong as weak aluminum alloys but only 60 % heavier. Titanium has outstanding corrosion resistance to seawater and is commonly used in different parts of ships exposed to saltwater. Titanium and its alloys are also used in airframe forging, tubing and tankage components, gas turbine compressor components, and rockets where strength, low weight, and resistance to high temperatures are essential.

Due to high biocompatibility, Titanium and its alloys are used to create artificial hips, pins for setting bones, and for other biological implants. Such alloys have very high tensile strength and toughness, even at extreme temperatures.

The downside of Titanium: it's difficult to analize. As a so-called 'trace' element, which has always been a challenge for optical spectrometry Titanium's emitted spectrum is very line-rich. Spectrometers with a poor spectral resolution quickly reach their limits here, since the spectral lines are often overlaid and disturbed by others. In some systems, you can even see only one single line where there are several existing. With the OE750, offering the complete wavelength range with an outstanding resolution, makes it possible to determine Titanium. Since it's generally better to avoid spectral interference than to compensate for it, the line selection of the OE750 has been optimized for this purpose.

The most common Ti alloy 6Al 4V consists of 6% aluminum and 4% vanadium. The combination of all elements produces a massive number of spectral lines. A spectrometer with high resolution is essential for this as well.

Hydrogen's interaction with Titanium-based alloys can have serious consequences for the material properties. Therefore it's essential to determine the hydrogen content in Titanium accurately. The OE750 offers outstanding detection limits for the determination of hydrogen in Titanium – and is the only spark spectrometer in this price range for this application.

The OE750 is designed to meet the exacting requirements of the Titanium industries, especially those demanding lower detection limits for silicon, palladium and ruthenium. It'd also able to analyze gases such as hydrogen, oxygen and nitrogen meeting the requirements of typical Titanium grades where those elements are specified.

SAMPLE PREPARATION

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 analyzed.

Our recommendation is to use a milling machine equipped with indexable inserts specified for aluminum alloys. The machine should be optimized for each Ti alloy.

Alternatively, you can use a turning lathe.

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

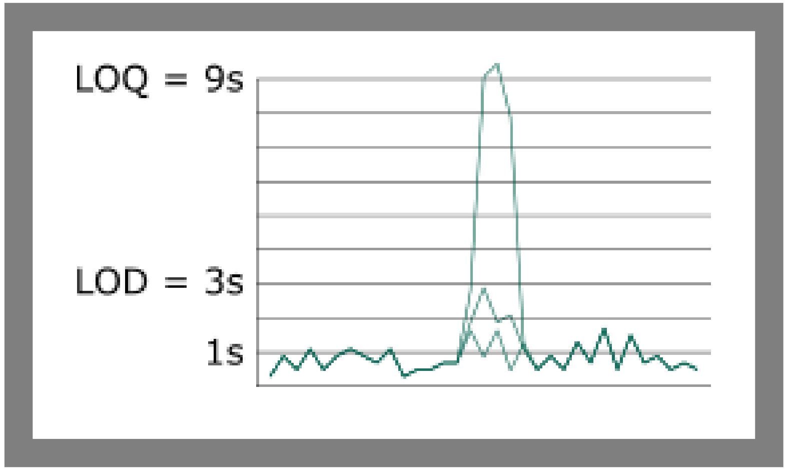
DIFFERENCE BETWEEN LOD AND LOQ

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 an alloyed copper base down to the level of precision (1δ).

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



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

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SUB-programs & calibration range Ti base

		Ti 000		Ti 100		Ti 200		Ti 300		Ti 400	
		Ti Global		Pure Titanium		Ti-Al/Sn/Zr/Mo		Ti-Al/V alloy		Gases in Ti alloy	
		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	0.12
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	1	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	0.025	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	4.5	0.001	0.012	0.001	4.5	0.001	4	0.001	4.5

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Table of precision Ti alloys

Element	Al	C	Cr	Cu	Fe	H	Mn	Mo	N	Nb
Limit of detection (ppm)	5	2	20	10	1	5	5	5	15	2
Concentration range (%)	0.0005-9	0.0002-0.12	0.002-7.5	0.001-3	0.0001-2.2	0.0005-0.015	0.0005-8	0.0005-7.5	0.0015-0.03	0.0002-8
Precision (1s) in % - ranges										
0.001	0.0005	0.0005			0.0002	0.0001	0.0001	0.0001		0.0001
0.005	0.002	0.0007	0.0005	0.0005	0.0003	0.0005	0.0002	0.0003	0.001	0.0002
0.01	0.003	0.001	0.0007	0.0008	0.0005	0.007	0.0003	0.0005	0.002	0.0005
0.05	0.005	0.002	0.001	0.001	0.0015	0.002	0.0007	0.0007	0.007	0.007
0.1	0.007	0.005	0.0015	0.005	0.0025		0.001	0.002		0.001
0.5	0.01	0.01	0.0035	0.015	0.01		0.002	0.004		0.002
1	0.02		0.005	0.02	0.015		0.004	0.005		0.008
5	0.04		0.05	0.03	0.025		0.06	0.02		0.02
10	0.05		0.2				0.1	0.05		0.04
20										

Element	Ni	O	Pd	Ru	Si	Sn	Ta	V	W	Zr
Limit of detection (ppm)	2	100	30	10	10	5	30	10	30	10
Concentration range (%)	0.0002-1	0.01-0.4	0.003-0.2	0.001-0.2	0.001-1	0.0005-12	0.003-1.2	0.001-18	0.003-1.2	0.001-4.5
Precision (1s) in % - ranges										
0.001	0.0001					0.0002				
0.005	0.0002		0.0004	0.0005	0.0005	0.0003	0.009	0.0002	0.0002	0.0002
0.01	0.0003		0.001	0.001	0.0008	0.0005	0.001	0.0005	0.0005	0.0009
0.05	0.0005	0.005	0.002	0.0015	0.001	0.0009	0.0015	0.001	0.002	0.0015
0.1	0.001	0.01	0.002	0.003	0.0025	0.001	0.002	0.002	0.005	0.01
0.5	0.003	0.02	0.005	0.004	0.005	0.002	0.005	0.003	0.02	0.02
1	0.006				0.01	0.005	0.01	0.03	0.05	0.05
5						0.03	0.05	0.04		0.1
10						0.05		0.05		
20						0.1		0.07		

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.