Application Note: 41402

Titanium Base

ARL 9900 Series with IntelliPower™ Simultaneous-Sequential XRF Spectrometer

Key Words

- ARL 9900 Series - 3600W
- Titanium
- X-Ray Fluorescence
- XRF

Titanium and alloys

Because of high tensile strength (even at high temperatures), light weight, extraordinary corrosion resistance and ability to withstand extreme temperatures, titanium alloys are used in aircraft, armour plating, naval ships, spacecraft and missiles. It is used in steel alloys to reduce grain size and as a deoxidizer, and in stainless steel to reduce carbon content. Titanium is often alloyed with aluminium (to refine grain size), vanadium, copper (to harden), iron, manganese, molybdenum and with other metals.

Welded titanium pipe is used in the chemical industry for its corrosion resistance and is seeing growing use in petroleum drilling for its strength, light weight and corrosion resistance.

Titanium alloyed with vanadium is used in the outer skin of aircraft, fire walls, landing gear and hydraulic tubing.

Use of titanium in consumer products such as tennis rackets, golf clubs, bicycles, laboratory equipment and laptop computers is becoming more common.

Other uses:

- Due to excellent resistance to sea water, it is used to make propeller shafts and rigging and in the heat exchangers of desalination plants and in heater-chillers for salt water aquariums.
- Because it is considered to be physiologically inert, the metal is used in joint replacement implants such as hip ball and sockets and to make medical equipment and in pipe/tank lining in food processing. Titanium is also used for surgical instruments.
- Titanium alloys are also used in spectacle frames. This results in a highly durable and long lasting frame. Both traditional alloys and shape memory alloys find use in this application.
- Many backpackers use titanium equipment, including cookware, eating utensils, lanterns and tent stakes. Titanium products can be significantly lighter without compromising strength.

Instrumentation

The Thermo Scientific ARL 9900 WDXRF spectrometer can be configured as a simultaneous-sequential unit with up to 24 fixed channels and a universal goniometer.

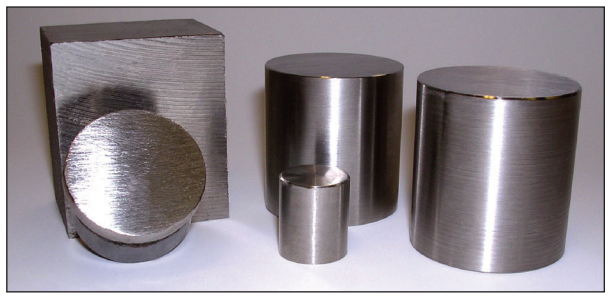
The instrument is fitted with a Rh anode X-ray tube and its geometry is optimized to provide the highest sensitivity. The configuration of the test instrument and the analytical conditions are shown in Table 1.

Ease of operation is obtained through the state-of-the-art OXSAS software running under MS-Windows XP Professional environment.

Elements	Fixed channel	Universal crystal	Universal goniometer	Universal collimator
Al	x			
Nb		LiF220	Sc	0.15
Cr	x			
Cu	x			
Fe	x			
Mn	x			
Mo	x			
Ni	x			
Si	x			
Sn	x			
V		LiF220	FPC	0.15
Zr		LiF220	Sc	0.15

Table 1: Analytical configuration

Sample preparation:
Titanium samples were prepared with abrasive paper.



Calibration and results

A series of titanium standards were used for calibration of the ARL 9900. The excitation conditions were 50kV/70mA and the counting time was 40s per element. The typical limits of detection are shown in Table 2.

Elements	LoD (40s) ppm	Range %		
Al	9.9	LoQ	–	8.1
Nb	3.1	LoQ	–	7.2
Cr	18.1	LoQ	–	3.6
Cu	2.6	LoQ	–	0.6
Fe	3.5	LoQ	–	2.2
Mn	6.1	LoQ	–	7.1
Mo	1.1	LoQ	–	6.1
Ni	2.9	LoQ	–	0.07
Si	2.5	LoQ	–	0.3
Sn	6.5	LoQ	–	3.5
V	28.1	LoQ	–	15
Zr	3.1	LoQ	–	4.8

Table 2: Typical limits of detection (LoD) and analytical range.
LoQ= limit of quantification is defined as 3xLoD

Precision test

A precision test was performed with a low alloy titanium sample using 40s counting time per element. Ten repeat analyses were performed on the same sample in order to show the repeatability of analysis that the ARL 9900 can provide for titanium alloys.

Device Run/Element	Fixed Al (ppm)	Fixed Cr (ppm)	Fixed Cu (ppm)	Fixed Fe (ppm)	Fixed Mn (ppm)	Fixed Mo (ppm)	Gonio Nb (ppm)	Fixed Ni (ppm)	Fixed Si (ppm)	Fixed Sn (ppm)	Fixed Ti (%)
1	348	98	30	2007	10	22	22	55	74	70	99.76
2	335	103	31	2008	14	22	21	55	75	64	99.82
3	340	103	30	2008	15	22	20	55	76	66	99.82
4	348	92	30	2008	15	22	18	55	73	64	99.79
5	345	97	30	2005	13	23	19	55	74	68	99.77
6	343	86	30	2012	14	22	19	54	75	67	99.85
7	345	97	30	2004	15	22	22	54	73	68	99.8
8	340	96	31	2014	16	22	20	55	74	69	99.79
9	339	95	30	2008	12	21	20	54	74	68	99.8
10	336	92	32	2009	10	22	20	54	72	65	99.79
Average	341.9	95.9	30.4	2008.3	13.4	22	20.1	54.6	74	66.9	99.8
Std Deviation	4.6	5.1	0.7	2.9	2.1	0.5	1.3	0.5	1.2	2.1	0.026
Unit	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	%

Table 3: Precision test for low alloy titanium

Instrument calibration

It should be stressed that an XRF spectrometer is a very accurate comparator, but the accuracy of the final analysis is entirely dependent on the quality of the standards used for calibration. The ARL 9900 spectrometer can be factory calibrated for a general titanium program using commercially available standards. It can also be calibrated on-site using well analyzed samples from the user.

Conclusion

The long experience of our company in metals analysis comes from an installed base of over two thousands XRF spectrometers world-wide. The ARL 9900 is the answer to your metallurgical analysis needs; whether they be incoming material control, metal QC or production analysis. Working 24 hours a day and 7 days a week, the ARL 9900 delivers dependable performance year after year. The high performance of the ARL 9900 will meet your analytical needs today and in the future.

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