SPECTRO XRF Report

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SPECTRO xSORT XHH03

AlloyPlus (Combi) version

Analysis of Solid Metal Samples

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Summary

Excitation of the fluorescence radiation in the sample by an X-ray tube has been optimized so that extremely short measuring times with a high sample throughput are possible. Specially developed detector technology, based on SDD, enables high signal throughput at high resolution; allowing for a unique analytical flexibility and a considerably accelerated signal processing.

With the SPECTRO xSORT AlloyPlus (SPECTRO xSORT Combi) it is possible to conduct laboratory-like analyses in a single measuring cycle that lasts only 2 seconds, except for the light elements Mg, Al, Si, P and S they require a longer measurement time. Only 5 additional seconds are necessary for the sorting of various aluminum and magnesium alloys. During this process even the light elements Al, Mg, Si, P and S are measured in air – without complicated additional techniques like helium flushing or vacuum, simplifying operation decidedly.

The analysis screen supplies the operator with all of the necessary information at a single glance and can display the measurement result in different views - also during measurement. The analytical results are stored and can be displayed later, printed and, after transfer to an external computer, processed with the “Result Manager” software.

1. Introduction

SPECTRO products are viewed around the world as standards for onsite metal analysis. No other company possesses comparable know-how and similarly comprehensive experience in this area.

As one of the leading international manufacturers of XRF instruments, laboratory analyses with extremely powerful X-ray fluorescence spectrometers is also an area in which SPECTRO excels.
With the SPECTRO xSORT, SPECTRO offers compact energy dispersive X-ray fluorescence spectrometer for the continuous, fatigue-free handheld analysis and sorting of metals.

It makes use of innovative efficient components for excitation and detection. Together with other top quality modules, they are the basis for the unique precision, speed and safety of this system; combining the experience with onsite metal analysis and the demands for laboratory quality measurement results.

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2. Instrumentation

To test an alloy group, SPECTRO calibration modules are preinstalled on the SPECTRO xSORT AlloyPlus (Combi).
For example, the testing of stainless steels requires the Alloy standard configuration. The measurement of precious metals does not require an additional module.
The measurement of Mg, Al, Si, P and S in alloys would require the configuration Alloy standard incl. “Light elements”. The measurement of precious metals is included here as well.

A single measuring cycle lasts only 2 seconds for the module „Standard“. Only 5 seconds in addition are necessary for both the sorting of various aluminum and magnesium alloys and the identification of different alloys including Mg, Al, Si, P and S with the module “Light Elements”.

3. Technical Data

Detector

- High resolution silicon drift detector (SDD)

Excitation

- X-ray tube with Rh anode
- up to 50 kV tube voltage

Operation

A sample name can be entered and then the start button can be released after the first result is displayed on the screen, or continue to press until the preset measurement time is elapsed.

Spectrometer Control

- Computer integrated
- Windows CE
- Bluetooth, WiFi, USB Host/Client

Dimensions and Weight

- Height: 270 mm (10,7“)
- Width: 93 mm (3.7”)
- Depth: 230 mm (9.1“)
- Weight instrument: 1.64 kg (3.62 lbs) including battery pack

Power/ Electrical Connection

- Battery operation with Li-polymer batteries, rechargeable (4 h typical duty cycle)
- 100 - 240 V, +/- 10 %, 50 / 60 Hz (AC adapter/ charger)
- 11 W during analysis
- 6 W standby mode
- 3 W offline mode

Options

- Additional battery pack
- Barcode reader (Bluetooth)
- Printer (Bluetooth)
- Wireless data transfer kit
- Small parts adapter
- Sample cups adapter
- Welding seam adapter
- Video camera (built in)
- GPS receiver (built in)
- Docking station(with carrying case)
    - With/without external computer

Accessories (Included)

- Transport case
- Instrument/battery holster
- Two battery packs
- Charger/ AC adapter
- USB cable
- Consumables

Software

- Eval-Server for data treatment and fundamental parameter analysis
- iCAL (intelligent Calibration Logic)
- Result Manager: post-processing of stored measurement values and protocols

Analysis Mode

- Automatic fingerprint analysis
- Automatic average calculation
- Calculation standard deviation and relative standard deviation

Grade ID Mode

- Grade identification based on stored library of grade specifications
- Grade verification, based on selected grade specification

- Optional display of analysis and/or grade identification
- Grade library easily edited and expanded

Sorting Mode

- Fast pass/fail assessment based on a reference sample
- Symmetrical and asymmetrical tolerances allowed
- Three modes of operation to suit different sorting tasks
- Log reports

Documentation

- Basic operator manual
- Back up on USB stick

4. Sample Preparation

To enhance accuracy samples can be prepared with grinding paper (approx. 60 or 80 grit aluminum or zirconium oxide) or a milling machine can be used.
For grade identification in most cases no sample preparation is necessary.
On most finished parts sample preparation is not necessary.

5. Detection Limits

In EDXRF the detection limits are sample specific. They are influenced by matrix effects, line overlaps as well as signal processing of the detector.

The following data are related to measurements of pure single element standards at a measuring time of 10 seconds for elements Z ≥ 21 respectively 20 seconds for Mg, Al, Si, P and S. While determining RoHS elements, measurement times of 60 seconds (light elements), respectively 10 seconds, are used. The identified LODs for RoHS analyses are displayed separately for aluminum and copper bases. The measurements are done using a 4 µm polypropylene film between sample and measuring head.

In consideration of line overlaps, pile ups and other detector artifacts the Eval-Server calculates detection limits and displays them as analysis result.

The LOD is calculated as 3 times standard deviation (SD).

Table 1: Iron base

Element	LOD [%]	Calibration ranges [%]	Calibration ranges [%] binary samples
Al	0.3	5	
Cd	0.03	0.3	
Co	0.09	45	
Cr	0.01	25	
Cu	0.007	10	30
Mn	0.02	12	
Mo	0.007	7	70
Nb	0.007	5	
Ni	0.02	75	
P	0.01	10	
Pb	0.02	0.35	
S	0.01	0.4	
Sb	0.04	0.3	
Si	0.03	20	
Sn	0.03	0.3	
Ti	0.02	5	
V	0.01	2	
W	0.04	30	
Zn	0.01	0.4	
Zr	0.007	0.3	

Table 2: Ferro Alloys

Element	LOD [%]	Calibration ranges [%]
Al	0.5	5
Co	0.1	18
Cr	0.02	75
Cu	0.01	3
Mn	0.02	80
Mo	0.01	7
Nb	0.01	5
Ni	0.02	75
P	0.02	10
Si	0.04	76
Ti	0.02	5
V	0.02	2
W	0.03	30

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Table 3: Nickel base

Element	LOD [%]	Calibration ranges [%]	Calibration ranges [%] binary samples
Ag	0.03	0.3	
Al	0.4	6	
Cd	0.03	0.3	
Co	0.02	19	
Cu	0.06	33	
Cr	0.01	30	
Fe	0.01	50	
Hf	0.05	3	
Mn	0.01	1.5	
Mo	0.01	27	70
Nb	0.01	5.3	
Pb	0.04	0.4	
Re	0.06	3	
Sb	0.04	0.3	
Si	0.03	0.9	
Sn	0.04	0.3	
Ta	0.06	6.3	
Ti	0.01	5	
V	0.01	5	
W	0.04	15	30
Zn	0.04	0.37	

Table 4: Tungsten Carbides

Element	LOD [%]	Calibration ranges [%]
Co	0.2	3
Cr	0.05	0.5
Cu	0.5	15
Fe	0.04	0.5
Mn	0.04	5
Mo	0.06	0.5
Nb	0.06	0.5
Ni	0.2	9
Sn	0.3	1.0
Ta	0.6	1.0
Ti	0.07	0.5
V	0.07	0.5
Zr	0.07	0.3

Table 5: Titanium base

Element	LOD [%]	Calibration ranges [%]
Al	0.3	33
Cd	0.01	0.3
Co	0.008	0.4
Cr	0.01	3
Cu	0.005	2.6
Fe	0.006	3.1
Mn	0.008	1.3
Mo	0.003	6
Nb	0.003	6.3
Ni	0.009	0.4
Pd	0.01	0.2
Ru	0.01	0.13
Si	0.03	0.47
Sn	0.01	12
Ta	0.02	0.3
V	0.1	15
Zn	0.004	0.4
Zr	0.004	50

Table 6: Cobalt base

Element	LOD [%]	Calibration ranges [%]	Calibration ranges [%] binary samples
Al	0.3	1.0	50
Cd	0.03	0.3	
Cr	0.008	33	
Cu	0.02	18	
Fe	0.02	50	
Mn	0.01	3	
Mo	0.008	30	
Nb	0.007	5	
Ni	0.06	35	
Pb	0.04	0.4	
Si	0.04	17	
Sn	0.3	2.5	
Ta	0.03	3.35	
Ti	0.01	3	
V	0.01	5	
W	0.05	16	63
Zn	0.01	0.4	
Zr	0.008	0.3	

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Table 7: Copper base

Element	LOD [%]	Calibration ranges [%]	Calibration ranges [%] binary samples
Ag	0.03	2	25
Al	0.2	11	
As	0.01	0.06	
Bi	0.03	3	
Cd	0.04	0.3	
Co	0.007	0.5	32
Cr	0.008	0.9	
Fe	0.008	4	
Mn	0.005	14	
Mo	0.01	0.3	
Ni	0.02	30	
P	0.01	10	
Pb	0.04	10	
Sb	0.06	0.2	
Se	0.01	0.9	
Si	0.03	3.2	
Sn	0.04	17	
Te	0.05	0.24	
Ti	0.01	0.4	
V	0.01	0.4	
W	0.05	4.5	
Zn	0.08	40	

Table 8: Aluminum base

Element	LOD [%]	Calibration ranges [%]
Ag	0.003	0.3
Bi	0.003	0.6
Cd	0.004	0.2
Co	0.003	10
Cr	0.004	0.3
Cu	0.002	5
Fe	0.005	0.6
Mg	0.1	5
Mn	0.002	1.1
Mo	0.001	65
Nb	0.001	25
Ni	0.008	2.15
Pb	0.003	1
Sb	0.005	10
Sc	0.01	2
Si	0.03	20
Sn	0.003	0.09
Sr	0.001	10
Ti	0.01	5
V	0.006	0.1
Zn	0.01	6
Zr	0.001	0.2

Table 9: Lead base

Element	LOD [%]	Calibration ranges [%]
Ag	0.1	3.3
As	0.1	0.6
Bi	0.2	0.27
Cd	0.02	0.2
Co	0.02	0.2
Cu	0.02	0.2
Fe	0.02	0.5
Cr	0.03	0.3
Mn	0.03	0.5
Ni	0.01	0.3
Sb	0.08	13
Sn	0.1	20
Ti	0.05	0.3
V	0.03	0.3
Zn	0.02	0.5

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Table 10: Magnesium base

Element	LOD [%]	Calibration ranges [%]
Ag	0.003	2.6
Al	0.02	10
Cd	0.003	0.2
Ce	0.02	1.6
Co	0.003	0.3
Cr	0.002	3.9
Cu	0.001	0.33
Fe	0.003	0.5
La	0.01	0.6
Mn	0.002	0.4
Mo	0.0008	0.5
Nb	0.001	0.5
Nd	0.04	3.8
Ni	0.001	0.04
Pb	0.009	1
Pr	0.03	0.18
Sb	0.005	0.3
Sc	0.004	0.21
Si	0.003	0.29
Sn	0.004	0.3
Th	0.003	2.3
Ti	0.004	0.4
Y	0.0008	0.2
Zn	0.001	0.67
Zr	0.0007	0.67

Table 11: Gold base

Element	LOD [%]	Calibration ranges [%]
Ag	0.05	100
Cd	0.09	13
Co	0.01	0.6
Cr	0.03	0.2
Cu	0.02	55
Fe	0.02	0.5
In	0.06	2
Mn	0.02	0.032
Ni	0.02	8
Pb	0.1	5
Pd	0.08	1
Pt	0.2	19
Rh	0.12	0.2
Ru	0.03	0.2
Sn	0.07	4
Ti	0.04	0.3
V	0.03	0.02
Zn	0.04	15

Table 12: Zinc base

Element	LOD [%]	Calibration ranges [%]
Ag	0.04	3
Al	0.2	4
Bi	0.03	0.3
Cd	0.04	0.4
Co	0.01	0.5
Cr	0.01	0.02
Cu	0.02	3
Fe	0.008	0.5
Mn	0.01	0.03
Ni	0.02	4
P	0.01	0.2
Pb	0.03	0.2
Sb	0.05	0.3
Se	0.01	0.1
Si	0.04	0.1
Sn	0.04	0.3
Ti	0.02	0.3
V	0.01	0.3

Table 13: Tin base

Element	LOD [%]	Calibration ranges [%]
Ag	0.02	2.5
Al	0.1	1
As	0.006	0.5
Bi	0.02	0.3
Cd	0.03	0.1
Co	0.01	0.5
Cr	0.02	17
Cu	0.008	5
Fe	0.01	0.5
Ge	0.005	0.5
Mn	0.01	1.9
Mo	0.005	0.6
Nb	0.006	0.5
Ni	0.008	9
P	0.02	0.14
Pb	0.02	40
Pd	0.01	0.4
S	0.02	0.4
Sb	0.06	10
Se	0.01	0.09
Si	0.08	0.6
Ti	0.06	0.3
V	0.02	0.3
Zn	0.008	0.5

Table 14: Zirconium base

Element	LOD [%]	Calibration ranges [%]
Cd	0.07	0.3
Co	0.02	0.3
Cu	0.02	0.5
Cr	0.02	0.2
Fe	0.02	0.5
Mn	0.02	0.2
Mo	0.09	0.3
Nb	0.04	0.1
Ni	0.02	0.2
Pb	0.03	0.3
Sb	0.1	0.5
Sn	0.1	1
Ti	0.04	0.2
V	0.03	0.1
W	0.03	0.05
Zn	0.01	0.4

Table 15: Platinum base

Element	LOD [%]	Calibration ranges [%]
Ag	0.03	1.6
Au	0.2	5
Cd	0.05	13
Co	0.01	5
Cr	0.03	0.2
Cu	0.02	4
Fe	0.02	0.5
Ir	0.2	20
Mn	0.03	0.2
Ni	0.02	1
Pd	0.04	1
Rh	0.05	0.3
Ru	0.05	0.3
Ti	0.04	0.2
V	0.05	0.2
W	0.6	5
Zn	0.01	5

Table 16: Silver base

Element	LOD [%]	Calibration ranges [%]
Au	0.02	62
Cd	0.05	13
Co	0.01	0.5
Cu	0.01	100
Fe	0.01	0.5
Mn	0.01	0.032
Ni	0.01	0.6
V	0.02	0.02
Zn	0.008	5

Table 17: Palladium base

Element	LOD [%]	Calibration ranges [%]
Ag	0.08	100
Cr	0.02	0.2
Cu	0.01	5
Fe	0.01	0.5
Mn	0.01	0.032
Ti	0.04	0.3
V	0.03	0.2
Zn	0.01	0.2

Table 18: RoHS elements in aluminum base

Element	LOD [%]	Calibration ranges [%]
Cr	0.0007	0.9
Cd	0.0006	0.2
Hg	0.0008	0.1
Pb	0.0006	1.0

Table 19: RoHS elements in copper base

Element	LOD [%]	Calibration ranges [%]
Cr	0.001	0.9
Cd	0.007	0.2
Hg	0.006	0.1
Pb	0.007	1.0

6. Some Typical Measurement Examples

Analysis pauses are used to correct possible gain shifts. This procedure guarantees reproducible and accurate results as shown in the tables at different and changing ambient temperatures**.**
(ASD: Analytical Standard Deviation of 5 measurements)
All data in mass percentage

Table 20: Aluminum base

1100 AL				
		Analysis [%]	**ASD [%]**	**Certificate [%]**
Al	20s	99.10	0.01	99.11
Cr	2s	0.029	0.003	0.021
Cu	2s	0.148	0.002	0.14
Fe	2s	0.503	0.002	0.50
Mg	20s	<0.1		-
Mn	2s	0.028	0.001	0.032
Si	20s	0.081	0.008	0.1
Ti	2s	0.032	0.003	0.027
V	2s	0.008	0.002	0.020
Zn	2s	0.0351	0.0004	0.029
Al	20s	99.10	0.01	99.11

2014AD AB				
		Analysis [%]	**ASD [%]**	**Certificate [%]**
Al	20s	92.9	0.1	92.89
Bi	2s	0.028	0.003	0.025
Cr	2s	0.028	0.002	0.050
Cu	2s	4.48	0.01	4.26
Fe	2s	0.459	0.004	0.46
Mg	20s	0.41	0.10	0.45
Mn	2s	0.775	0.006	0.81
Ni	2s	0.043	0.002	0.028
Pb	2s	0.023	0.001	0.023
Si	20s	0.75	0.02	0.88
Sn	2s	0.031	0.002	0.037
Ti	2s	0.035	0.001	0.03
V	2s	0.020	0.003	0.018
Zn	2s	0.033	0.001	0.029

AA-4643				
		Analysis [%]	ASD [%]	Certificate [%]
Al	20s	95.62	0.08	95.59
Bi	2s	0.021	0.001	0.019
Cr	2s	0.037	0.002	0.028
Cu	2s	0.037	0.004	0.04
Fe	2s	0.168	0.003	0.16
Mg	20s	0.13	0.08	0.1
Mn	2s	0.042	0.001	0.041
Si	20s	3.74	0.02	3.82
Sn	2s	0.013	0.002	0.017
Ni	2s	0.045	0.002	0.04
Pb	2s	0.019	0.001	0.02
Ti	2s	0.053	0.003	0.052
Zn	2s	0.039	0.001	0.031

6061 SS				
		Analysis [%]	ASD [%]	Certificate [%]
Al	20s	97.31	0.09	97.23
Cr	2s	0.250	0.002	0.229
Cu	2s	0.314	0.002	0.30
Fe	2s	0.353	0.001	0.35
Mg	20s	0.95	0.08	1.00
Mn	2s	0.053	0.001	0.052
Ni	2s	0.063	0.001	0.053
Si	20s	0.56	0.02	0.64
Ti	2s	0.038	0.008	0.037
Zn	2s	0.089	0.001	0.080

ROHS standard E4143				
		Analysis [µg/g]	ASD [µg/g]	Certificate [µg/g]
Cd	60s	93	2	88
Hg	60s	594	3	590
Pb	60s	40	3	110

ROHS standard E4146				
		Analysis [µg/g]	ASD [µg/g]	Certificate [µg/g]
Cd	60s	400	3	370
Hg	60s	59	3	62
Pb	60s	464	6	350

Table 21: Stainless and heat resisting steel

AISI 303				
		Analysis [%]	ASD [%]	Certificate [%]
Mn	2s	1.81	0.024	1.87
P	20s	0.036	0.004	0.032
S	20s	0.29	0.01	0.378
Si	20s	0.65	0.05	0.634
Cr	2s	17.43	0.03	17.35
Co	2s	0.28	0.03	0.31
Cu	2s	0.52	0.02	0.51
Nb	2s	0.056	0.003	0.056
Ni	2s	8.52	0.02	8.64
Mo	2s	0.58	0.003	0.58
V	2s	0.111	0.002	0.107

AISI 416				
		Analysis [%]	ASD [%]	Certificate [%]
Mn	2s	0.37	0.01	0.35
P	20s	0.032	0.004	0.026
S	20s	0.35	0.01	0.29
Si	20s	0.39	0.01	0.37
Cr	2s	12.14	0.02	12.25
Cu	2s	0.136	0.008	0.155
Mo	2s	0.086	0.003	0.08
Ni	2s	0.25	0.01	0.24
V	2s	0.026	0.005	0.024

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Table 22: Aerospace materials

17-7PH				
		Analysis [%]	ASD [%]	Certificate [%]
Mn	2s	0.78	0.02	0.76
P	20s	0.023	0.004	0.023
S	20s	<0.04		0.0019
Si	20s	0.38	0.03	0.361
Co	2s	0.16	0.02	0.17
Cr	2s	17.01	0.05	16.94
Cu	2s	0.32	0.01	0.31
Mo	2s	0.50	0.01	0.51
Nb	2s	0.028	0.003	0.033
Ni	2s	7.03	0.05	7.22
Ti	2s	0.112	0.007	0.115
V	2s	0.094	0.002	0.091
Al	20s	1.0	0.1	1.19

Table 23: Materials with special physical properties

Nitronic 60				
		Analysis [%]	ASD [%]	Certificate [%]
Mn	2s	8.50	0.03	8.58
P	20s	0.035	0.003	0.032
Si	20s	3.56	0.13	3.67
Cr	2s	16.56	0.02	16.37
Cu	2s	0.38	0.02	0.362
Mo	2s	0.295	0.002	0.31
Ni	2s	8.50	0.07	8.5
V	2s	0.060	0.003	0.058

Table 24: 11% Manganese steel

SS-CRM No. 493/1				
		Analysis [%]	ASD [%]	Certificate [%]
Mn	2s	11.79	0.05	11.74
P	20s	0.094	0.007	0.098
S	20s	<0.027		0.012
Si	20s	0.76	0.02	0.86
Cr	2s	0.178	0.004	0.178
Ni	2s	3.01	0.05	3.01
Mo	2s	0.96	0.02	0.955

Table 25: Copper base

CDA 623				
		Analysis [%]	ASD [%]	Certificate [%]
Al	20s	8.3	0.1	9.19
Mn	2s	0.172	0.006	0.16
Fe	2s	2.13	0.02	2.13
Ni	2s	0.087	0.01	0.075

CDA 706				
		Analysis [%]	ASD [%]	Certificate [%]
Mn	2s	0.62	0.01	0.62
Fe	2s	1.34	0.02	1.30
Ni	2s	10.09	0.02	10.03
Zn	2s	0.06	0.01	0.082
Mn	2s	0.62	0.01	0.62

Table 26: Nickel base

Monel R405				
		Analysis [%]	ASD [%]	Certificate [%]
Si	20s	0.05	0.01	0.046
Mn	2s	0.98	0.01	1.03
Fe	2s	1.33	0.01	1.31
Co	2s	0.02	0.005	0.02
Cu	2s	32.9	0.2	32.3

RENE 142				
		Analysis [%]	ASD [%]	Certificate [%]
Al	20s	5.4	0.1	6.13
Cr	2s	7.17	0.01	6.98
Co	2s	12.35	0.06	11.81
Mo	2s	1.501	0.008	1.51
Hf	2s	1.29	0.02	1.34
Ta	2s	5.91	0.3	6.3
Ti	2s	0.17	0.01	0.11
W	2s	5.13	0.08	4.92
Re	2s	2.57	0.07	2.6

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Table 27: Cobalt base

Ultimet 1233				
		Analysis [%]	ASD [%]	Certificate [%]
Si	20s	0.17	0.04	0.24
Cr	2s	25.22	0.04	25.4
Mn	2s	0.780	0.02	0.79
Fe	2s	3.04	0.02	2.99
Ni	2s	9.62	0.03	9.47
Mo	2s	4.72	0.02	4.72
V	2s	0.023	0.005	0.02
W	2s	2.39	0.08	2.39

Table 28: Titanium base

Ti 6-6-2				
		Analysis [%]	ASD [%]	Certificate [%]
Al	20s	5.18	0.08	5.57
Si	20s	0.058	0.004	0.026
V	2s	5.56	0.04	5.57
Fe	2s	0.59	0.02	0.56
Ni	2s	0.046	0.002	0.015
Cu	2s	0.528	0.005	0.51
Mo	2s	0.008	0.002	0.008
Sn	2s	1.99	0.02	1.99

Table 29: Magnesium base

Mg 468 HL				
		Analysis [%]	ASD [%]	Certificate [%]
Mg	10s	95.24		96.14
Mn	2s	0.22	0.01	0.2
Cu	2s	0.091	0.001	0.09
Zn	2s	2.74	0.01	2.52
La	2s	0.28	0.01	0.23
Ce	2s	0.66	0.02	0.6
Nd	2s	0.27	0.02	0.2

7. Conclusion

With the SPECTRO xSORT AlloyPlus (xSORT Combi) it is possible to conduct laboratory-like analyses in a single measuring cycle that lasts only 2 seconds. For integration of the light elements Mg, Al, Si, P and S within an analysis only 20 additional seconds are necessary. For the quick alloy identification (including light elements) only 5 additional seconds are necessary. During this process even the light elements are measured in air – without complicated techniques like helium flushing or vacuum, simplifying operation decidedly.

The Eval-Server corrects line-overlaps and all detector artifacts and determines the sample composition using fundamental parameter.

The LODs listed in this report show excellent sensitivity of the SPECTRO xSORT AlloyPlus (xSORT Combi). The typical analysis results demonstrate outstanding precision and accuracy.

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