SPECTRO XRF Report

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SPECTRO xSORT XHH03

Analysis of Ores, Concentrates and Tailings

SPECTRO Analytical Instruments, Kleve, Germany

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; Normally, the analysis of an ore, a concentrate or tailings is complete within 30 seconds. This report describes the strengths of the SPECTRO xSORT based on the analysis of widely varying samples from ore winning and processing.

1. Introduction

X-ray fluorescence analysis (XRF) has been utilized for the rapid examination of ores, concentrates and tailings onsite for many years.

With the SPECTRO xSORT, a portable, compact XRF analyzer for the onsite screening of varying samples in mining is available. Its calibration is based on the successful calibration models used in SPECTRO´s laboratory instruments.

This report describes the strengths of the SPECTRO xSORT based on the analysis of widely varying samples.

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2. Instrumentation

SPECTRO calibration modules based on the fundamental parameters model for characteristic as well as scattered radiation were installed on the SPECTRO xSORT for the elemental analysis of minerals, ores, tailings or concentrates. The instrument is available as the basic variant and as the xSORT ECM variant for shorter measuring times.

With the SPECTRO xSORT ECM, only 30 seconds are necessary for the analysis of a sample. The short measuring time is very advantageous, because it is often necessary to measure many samples at one location. Additionally, the xSORT automatically calculates the average of the individual measurements.

3. Technical Data

Detector

- High resolution silicon drift detector (SDD)

Excitation

- X-ray tube with Rh Anode
- Up to 50 kV tube voltage

4. Operation

The start button can be released when the first measured values, including any measurement errors, are displayed on the screen. The button can also be held until the preset measurement duration has been reached. The analytical results displayed after about 2 seconds are usually stable after 15 seconds, with the statistical measurement error decreasing as the analysis continues.

Instrument Control

- ePC with Windows Mobile
- Automatic drift correction
- SD card slot
- Bluetooth, WiFi, USB

Dimensions and Weight

- Height: 270 mm (10.7")
- Width: 93 mm (3.7")
- Depth: 230 mm (9.1")
- Weight: 1.64 kg (3.64 lb) incl. battery pack

Performance Data/Power Supply

- Operation with rechargeable Li-polymer batteries (typical operation duration: 4 h)
- 100 - 240 V, +/- 10%, 50/60 Hz (power supply/charger)
- 11 W during the measurement
- 6 W in standby mode
- 3 W in offline mode

Options:

- Additional battery pack
- Barcode reader (Bluetooth)
- Printer (Bluetooth)
- Wireless data transfer kit
- Small parts adapter
- Video camera
- Integrated GPS receiver
- Docking station

Accessories (Included)

- Instrument holster (also for additional battery pack)
- Transport case
- Two battery packs
- AC adapter/charger
- Consumables
- USB cable

Software

- Eval server for data processing and Fundamental Parameter Analysis
- iCAL (Intelligent Calibration Logic)

Documentation

- Operation manual
- Data backup - CD

5. Analysis and Sample Preparation

For the ores analyzed as examples here, loose powders instead of pressed pellets and measuring times of 30 s are generally sufficient. It is possible to improve the detection limits and repeatability with longer measuring times. The calibration installed on the instrument is optimized for the typically occurring Cu, CuCo, NiCu, Zn, ZnPb, U and rare earth elements and ore processing materials.

The sample should be dried and ground before the analysis. In order to minimize mineralogical and particle size effects, a minimum particle size of < 100µm is recommended. Direct measurement of the stone for a screening measurement is also supported by the xSORT. Inhomogeneities in the stone can be reduced by multiple measurements at different spots. The elements Mg, Al, Si, P, S, K and Ca could be analyzed in a second measurement segment. The second measurement segment of, e.g., 30 s with the xSORT ECM is recommended to improve the accuracy and repeatability of the analytical results.

6. xSORT Calibration and Validation

When analyzing ores and samples from ore processing, especially those with high metal contents, it is necessary to carefully take matrix influences into consideration. Correction of matrix influences is improved when as many matrix elements as possible (e.g., Al, Si and S) are considered during the measurement and analysis. A second measurement segment for the analysis of sulfur is especially recommended when mixed ores contain oxide and sulfide components. The calibration model used does not need pre-defined element bonds, such as oxide, and is thus suited to strongly varying deposits. It is also possible to use known production samples in the instrument calibration providing general improvement to the accuracy for a given type of sample. The quantitative analysis of the elements Mg, Al, Si, P, S, Cl, K and Ca based on the pre-installed xSORT calibration can frequently be improved by using known ore or processing samples from storage in the calibration for these elements. This reduces the error due to different grain size distribution between the standards used for the calibration and the samples to be analyzed.

Validation of the calibrations pre-installed on the xSORT was conducted by analyzing various AMIS standards. The concentration ranges for the method validation are summarized in table 1.

Table 1: Concentration ranges for the method validation

Element	Maximum concentration	Element	Maximum concentration
	[%]		[%]
Si	44.6	Sr	5.3
P	14.5	Nb	0.4
S	28.1	Mo	0.3
Ti	13.7	Sn	1.1
V	0.3	Ba	6.0
Cr	14.7	La	3.0
Mn	35.3	Ce	4.0
Fe	43.6	Pr	0.3
Co	3.2	Nd	1.0
Ni	4.6	Ta	0.8
Cu	15.3	Pb	3.3
Zn	12.7	Th	0.1
As	9.3	U	0.3

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7. Analytical Results

The analytical errors displayed in the following tables 2 to 11 contain only the count statistical error with a confidence level of 95 % (2 sigma).
The total measuring time was 60 s.

Table 2: Comparison between given and analyzed concentrations for the Cu ore AMIS 0118

Element	Given	Analyzed
	[%]	[%]
Cu	0.484	0.485± 0.004
Si	25.6	24.0 ± 0.3
S	0.30	0.266 ± 0.008
K	0.556	0.50 ± 0.01
Ca	0.372	0.391 ± 0.006
Ti	0.70	0.76 ± 0.01
Mn	0.070	0.067 ± 0.004
Fe	9.04	8.92 ± 0.03
U	0.0031	0.0031 ± 0.0005

Table 3: Comparison between given and analyzed concentrations for the Cu Co ore AMIS 0159

Element	Given	Analyzed
	[%]	[%]
Cu	1.002	0.998 ± 0.004
Co	0.160	0.152 ± 0.003
Si	43.2	41.6 ± 0.1
P	0.18	0.15 ± 0.01
K	0.183	0.105 ± 0.005
Ca	0.400	0.370 ± 0.004
Fe	1.287	1.237 ± 0.008
Ni	0.0062	0.0061 ± 0.0007
As	0.00055	0.0005 ± 0.0002
Rb	0.0008	0.0010 ± 0.0002
Sr	0.0027	0.0027 ± 0.0003
U	0.0063	0.0062 ± 0.0004

Table 4: Comparison between given and analyzed concentrations for the CuS ore AMIS 0120

Element	Given	Analyzed
	[%]	[%]
Cu	15.32	14.98 ± 0.04
Si	13.0	15.4 ± 0.1
S	18.0	19.5 ± 0.1
Ti	0.29	0.34 ± 0.03
Fe	18.74	18.85 ± 0.05

Table 5: Comparison between given and analyzed concentrations for the TaNb ore NCSDC 86315

Element	Given	Analyzed
	[%]	[%]
Nb	0.364	0.370 ± 0.001
Ta	0.835	0.857 ± 0.007
Si	33.8	32.8 ± 0.1

Table 6: Comparison between given and analyzed concentrations for the Pt concentrate AMIS 0164

Element	Given	Analyzed
	[%]	[%]
Pt	24.5 µg/g	22 ± 7 µg/g
Cu	2.42	2.45 ± 0.01
Ni	3.60	3.65 ± 0.01
Zn	0.061	0.065 ± 0.001
Si	14.6	16.4 ± 0.1
S	11.6	11.27 ± 0.06
Fe	17.69	18.07 ± 0.03

Table 7: Comparison between given and analyzed concentrations for the Magnetite standard AMIS 0129

Element	Given	Analyzed
	[%]	[%]
Ti	13.75	13.91 ± 0.05
V	0.269	0.22 ± 0.01
Fe	43.58	43.1 ± 0.1
Si	4.47	4.9 ± 0.1

Table 8: Comparison between given and analyzed concentrations for the ZnO ore AMIS 0144

Element	Given	Analyzed
	[%]	[%]
Zn	17.36	17.45 ± 0.03
Ti	0.20	0.19 ± 0.03
Fe	2.42	1.92 ± 0.01
Cd	0.021	0.018 ± 0.001
Ba	0.35	0.37 ± 0.01
Si	23.3	19.1 ± 0.1

Table 9: Comparison between given and analyzed concentrations for the ZnPbS ore AMIS 0149

Element	Given	Analyzed
	[%]	[%]
Zn	15.6	16.11 ± 0.03
Pb	1.71	1.73 ± 0.01
Fe	2.81	2.82 ± 0.03
Cd	0.035	0.033 ± 0.003
Si	23.3	23.6 ± 0.3
S	10.3	10.65 ± 0.05

Table 10: Comparison between given and analyzed concentrations for the U ore AMIS 0186

Element	Given	Analyzed
	[µg/g]	[µg/g]
U	2749	2750 ± 10
Th	319	327 ± 8
Mo	271	264 ± 7

Table 11: Comparison between given and analyzed concentrations for the REE standard AMIS 0185

Element	Given	Analyzed
	[%]	[%]
Ba	5.98	5.96 ± 0.03
La	3.00	2.91 ± 0.03
Ce	4.08	3.92 ± 0.04
Pr	0.347	0.34 ± 0.06
Nd	0.920	0.93 ± 0.07
Si	10.18	10.39 ± 0.06
Sr	5.33	5. 39 ± 0.01

8. Summary

The analytical results presented here show that the SPECTRO xSORT is well suited to the rapid analysis of ores, minerals, tailings, concentrates and discard materials. As can be seen by the given analytical error for a total measuring time of 60 s, it would be possible to complete a screening analysis after only 30 s.

The short measuring time enables more sample taking and average determinations of the analytical results.

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TÜVRheinland CERT ISO 9001

GERMANY
SPECTRO Analytical Instruments GmbH
Boschstrasse 10
D-47533 Kleve
Tel: +49.2821.892.0
Fax: +49.2821.892.2202
spectro.sales@ametek.com

U.S.A.
SPECTRO Analytical Instruments Inc.
91 McKee Drive
Mahwah, NJ 07430
Tel: +1.800.548.5809
+1.201.642.3000
Fax: +1.201.642.3091
spectro-usa.sales@ametek.com

HONG KONG (Asia-Pacific)
AMETEK, Inc. SPECTRO Analytical Instruments (Asia-Pacific) Ltd.
Unit 1603, 16/F., Tower III
Enterprise Square
No. 9 Sheung Yuet Road
Kowloon Bay, Kowloon
Hong Kong
Tel.: +852.2976.9162
Fax: +852.2976.9542
spectro-ap.sales@ametek.com

Subsidiaries:
CHINA: Tel +86.10.8526.2111, Fax + 86.10.8526.2141, spectro-china.info@ametek.com.cn, FRANCE: Tel +33.1.3068.8970, Fax +33.1.3068.8999, spectro-france.sales@ametek.com, GREAT BRITAIN: Tel +44.1162.462.950, Fax +44.1162.740.160, spectro-uk.sales@ametek.com, INDIA: Tel +91.22.61968200, Fax +91.22.28363613, sales.spectroindia@ametek.com, ITALY: Tel +39.02.94693.1, Fax+39.02.94693.650, spectro-italy.sales@ametek.com, JAPAN: Tel +81.3.6809.2405, Fax + 81.3.6809.2410, spectro-japan.info@ametek.co.jp, SOUTH AFRICA: Tel +27.11.979.4241, Fax +27.11.979.3564, spectro-za.sales@ametek.com, SWEDEN: Tel +46.8.5190.6031, Fax + 46.8.5190.6034, spectro-nordic.info@ametek.com.
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