Application Note WDXRF1055

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XRF1055 - Quantitative analysis of aluminum alloy on Supermini200

Introduction

Aluminum alloy, which has the valuable properties of being both “light” and “strong”, is used in many industries such as automobile and aircraft. Since aluminum alloy has a broad range of grades whose characteristics are strongly dependent on the elemental compositions, it is very important to control the components. X-ray fluorescence (XRF) analysis quickly and easily offers precise elemental analysis results to make control of the components in aluminum alloy possible. This application note demonstrates the excellent performance of Supermini200 in aluminum alloy analysis.

Instrument

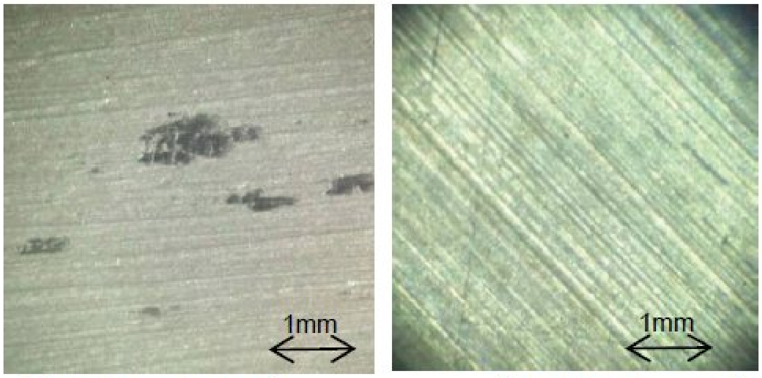
The Supermini200 is a benchtop sequential WDXRF spectrometer designed specifically to deliver excellent performance while eliminating typical installation requirements such as cooling water, special power supply, large floor space, and gas-free detector (in selecting the optional sealed proportional counter instead of the gas-flow proportional counter).

Featuring a unique air-cooled 200W X-ray tube, two detectors, selectable vacuum or helium environment, and three analyzing crystals, the Supermini200 can analyze elements from oxygen to uranium.

The Windows®-based software used to operate the Supermini200 shares the same platform running Rigaku’s popular high-power WDXRF ZSX family instruments. This means that it has the same advanced algorithms, multiple language support and an intuitive user-friendly interface.

Sample preparation

In XRF analysis, homogeneous samples with smooth analysis surfaces generally produce better results. Some grades of aluminum alloys, however, can be inhomogeneous (Figure 1). In such cases, smooth polishing can result in less accurate results, especially for Si, and it is preferable to use a rough belt grinder or file to polish to a rough surface.



Inhomogeneous sample Homogeneous sample

Figure 1: Aluminum alloy sample surface (microscope image)

Measurement and calibration

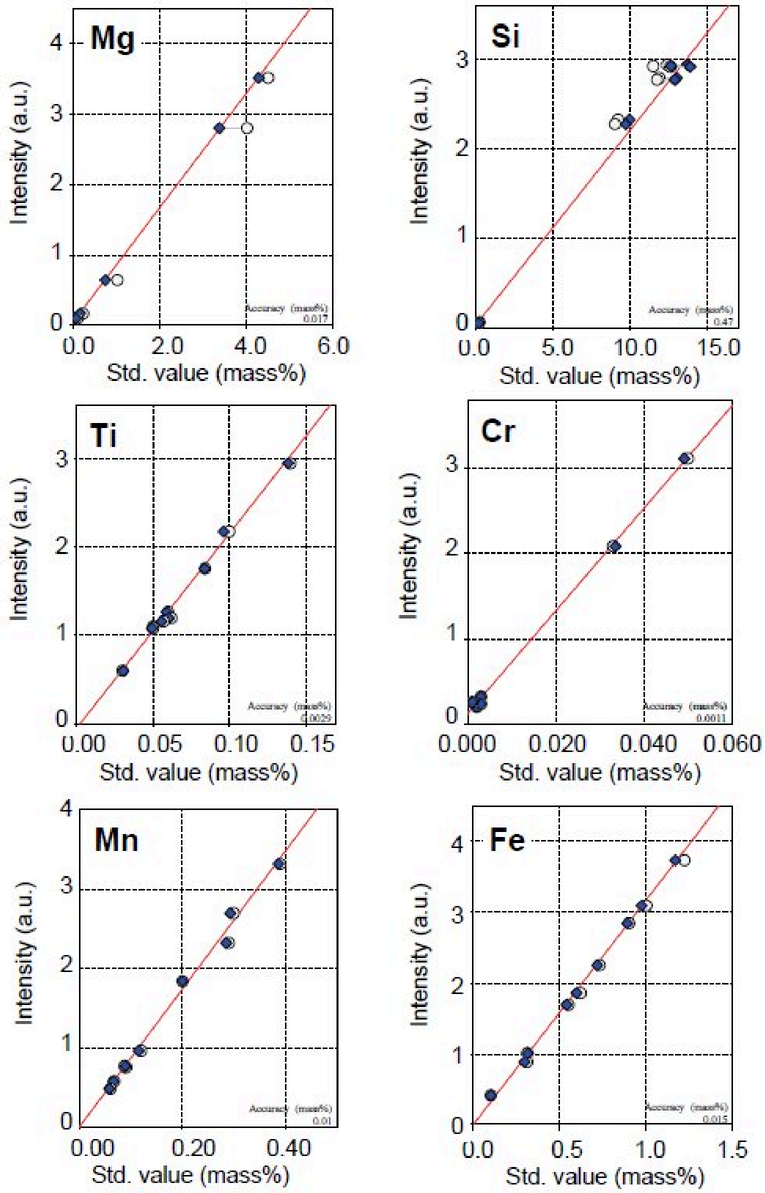
Measurements were performed on the Supermini200 for Mg, Si, Ti, Cr, Mn, Fe, Ni, Cu, Zn, Sn and Pb. For the measurement of Sn, a zirconium filter was used to reduce the background to improve the peak to back-ground ratio. Measurement conditions are shown in Table 1.

Table 1: Measurement condition

Element	**Mg**	**Si**	**Ti**	**Cr**
Line	Kα	Kα	Kα	Kα
kV-mA	50-4.00	50-4.00	50-4.00	50-4.00
Primary Filter	OUT	OUT	OUT	OUT
Slit	Std	Std	Std	Std
Crystal	RX25	PET	LiF(200)	LiF(200)
Detector	PC	PC	SC	SC
Time Peak (s)	20	20	100	30
BG(s)	20	10x2	20x2	10x2
Element	**Mn**	**Fe**	**Ni**	**Cu**
Line	Kα	Kα	Kα	Kα
kV-mA	50-4.00	50-4.00	50-4.00	50-4.00
Primary Filter	OUT	OUT	OUT	OUT
Slit	Std	Std	Std	Std
Crystal	LiF(200)	LiF(200)	LiF(200)	LiF(200)

Detector	SC	SC	SC	SC
Time Peak (s)	20	20	20	20
BG(s)	10x2	10x2	10x2	10x2
Element	**Zn**	**Sn**	**Pb**	
Line	Kα	Kα	Lβ1	
kV-mA	50-4.00 0	50-4.00	50-4.00	
Primary Filter	OUT	Zr200	OUT	
Slit	Std	Std	Std	
Crystal	LiF(200)	LiF(200)	LiF(200)	
Detector	SC	SC	SC	
Time Peak (s)	20	50	20	
BG(s)	10x2	10x2	10x2	

The calibration curves were generated using ALCOA spectrochemical standards KA332, KB413, KB514, KC413, SS332, SS380, SS384, SS413 and SS513. Matrix correction was applied to all calibration curves. The correction coefficients were calculated theoreti-cally by the fundamental parameter (FP) method. The calibration curves are shown in Figure 2 and the calibration results are listed in Table 2.


Mg
Intensity (a.u.)
Std. value (mass%)
Accuracy (mass%) 0.017
Si
Intensity (a.u.)
Std. value (mass%)
Accuracy (mass%) 0.47
Ti
Intensity (a.u.)
Std. value (mass%)
Accuracy (mass%) 0.0029
Cr
Intensity (a.u.)
Std. value (mass%)
Accuracy (mass%) 0.0011
Mn
Intensity (a.u.)
Std. value (mass%)
Accuracy (mass%) 0.01
Fe
Intensity (a.u.)
Std. value (mass%)
Accuracy (mass%) 0.015

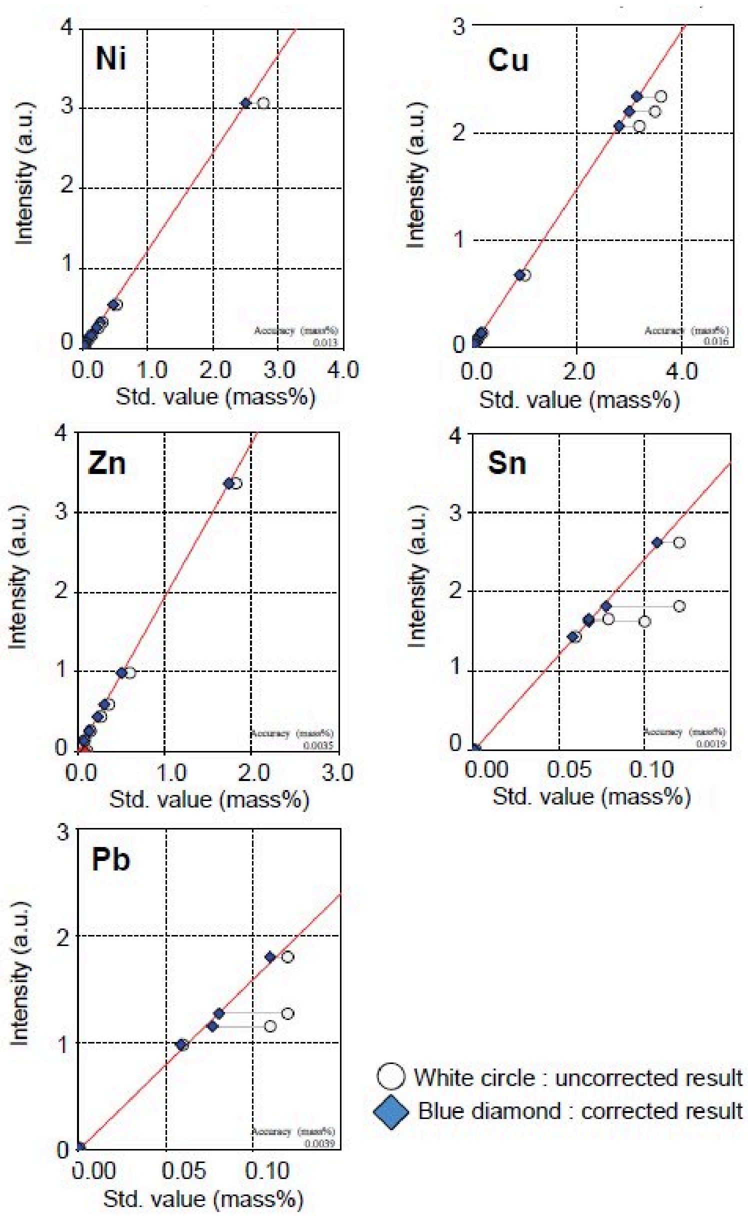


Figure 2: Calibration curves for Al alloy

Table 2: Calibration results (unit : mass%)

Element	Calibration range	Accuracy
Mg	0.001 - 4.50	0.017
Si	0.20 - 12.60	0.47
Ti	0.030 - 0.14	0.0029
Cr	0.001 - 0.05	0.0011
Mn	0.061 - 0.39	0.01

Fe	0.10 - 1.22	0.015
Cu	0.020 - 3.61	0.016
Ni	0.034 - 2.78	0.013
Zn	0.08 - 1.82	0.0035
Sn	0.001 - 0.12	0.0019
Pb	0.001 - 0.12	0.0039

The accuracy of the linear calibration curves are calculated by the following formula:

$$Accuracy = \sqrt{\frac{\sum_i (C_i - \hat{C}_i)^2}{n-2}}$$

C_i: calculated value of standard sample
$\hat{C}_i$: reference value of standard sample
n : number of standard samples.

Table 3: Repeatability test results for ALCOA KA380 (unit : mass%)

Element	Mg	Si	Ti	Cr	Mn	Fe	Cu	Ni	Zn	Sn	Pb
Certified value	0.45	9.49	0.120	0.062	0.16	1.1	3.10	0.45	0.15	0.20	0.11
N=1	0.428	10.05	0.113	0.058	0.153	1.09	3.12	0.439	0.148	0.197	0.105
2	0.436	10.06	0.114	0.060	0.153	1.09	3.11	0.440	0.148	0.195	0.105
3	0.430	10.03	0.116	0.057	0.155	1.09	3.12	0.440	0.150	0.195	0.104
4	0.432	10.04	0.114	0.058	0.153	1.09	3.12	0.439	0.149	0.198	0.105
5	0.432	10.04	0.114	0.057	0.155	1.09	3.12	0.438	0.149	0.199	0.106
6	0.428	10.04	0.113	0.059	0.154	1.10	3.12	0.439	0.149	0.198	0.106
7	0.427	10.05	0.114	0.058	0.152	1.09	3.12	0.442	0.149	0.196	0.105
8	0.427	10.06	0.115	0.058	0.154	1.09	3.13	0.440	0.149	0.198	0.104
9	0.423	10.03	0.114	0.058	0.155	1.09	3.11	0.439	0.149	0.197	0.106
10	0.428	10.00	0.113	0.056	0.153	1.09	3.11	0.441	0.149	0.195	0.105
Avg.	0.429	10.04	0.114	0.058	0.154	1.09	3.12	0.440	0.149	0.197	0.105
Max.	0.436	10.06	0.116	0.060	0.155	1.10	3.13	0.442	0.150	0.199	0.106
Min.	0.423	10.00	0.113	0.056	0.152	1.09	3.11	0.438	0.148	0.195	0.104
Range	0.013	0.05	0.003	0.004	0.003	0.01	0.02	0.004	0.002	0.004	0.002
Std. dev.	0.0036	0.016	0.0009	0.0011	0.0011	0.003	0.005	0.0012	0.0006	0.0015	0.0007
RSD %	0.83	0.16	0.83	1.90	0.69	0.29	0.16	0.26	0.38	0.75	0.70

Analysis results

Repeatability tests for ALCOA spectrochemical standard KA380 were carried out and the results are tabulated in Table 3. The results are very close to the certified values and the standard deviations are very small.

Conclusions

The results show that high precision and accurate analysis of elements in aluminum alloy can be rapidly performed using the benchtop WDX Supermini200. Even inhomogeneous element such as Si can be analyzed accurately with an appropriate sample preparation. Supermini200 is also effective for small commercial laboratories where analysis of various alloys and other sample types are required.

Related products

Supermini200

Benchtop tube below sequential WDXRF spectrometer anal yzes O through U in solids, liquids and powders