SHIMADZU
Excellence in Science

Application News

No.X245

X-ray Analysis

QC Analysis of Magnesium Alloy Die Castings by EDXRF

Magnesium alloy is the lightest of the metal alloys, with a density about two thirds that of aluminum alloy. Furthermore, due to its rich array of functionality, including strength, electromagnetic shielding, vibration absorption, and thermal radiation, etc., it is used in digital cameras, notebook computers, automobile parts and other products, and in the future, it is expected to replace aluminum alloy in many applications due to the ongoing trend toward lightweight products. Here, we introduce the standard quality control analysis by EDX of the widely specified magnesium alloy die casting, AZ91D.

Standard

Table 1 ASTM and JIS of Magnesium Alloy Die Castings (mass%)

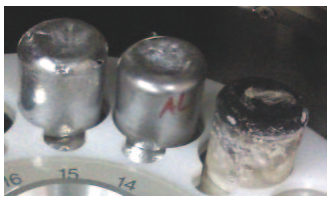
ASTM Code	JIS Code	Al	Zn	Mn	Si	Cu	Ni	Fe	Others
AZ91D	MDC1D	8.3-9.7	0.35-01.0	0.15-0.50	≤0.1	≤0.030	≤0.002	≤0.005	≤0.01

Samples

(1) Standard Samples
A) Magnesium Base by MBH Analytical Ltd.
① 65NHAZ61-H-91 ② 65NHAZ61-Y-91
③ 61NHR4-88 ④ 65XMgA2J
⑤ 65XMgA4H
B) Magnesium pure metal
C) Reagent magnesium oxide briquette
(2) Unknown Samples
Magnesium AZ91D quickly quench-molded die casting from molten metal



(1) A) Magnesium Base Standards



(2) Quickly Quench-Molded Molten Magnesium AZ91D

Fig. 1 Samples

Sample Preparation

After cutting by either lathe or milling, the surface is finished to Ra 1.6. To prevent contamination during cutting, cooling was conducted using ethanol instead of oil. (If oil is used, conduct ultrasonic cleaning in ethanol after cutting.) Magnesium powder is an explosive hazard, and as such, due care and preventive measures must be taken when processing.

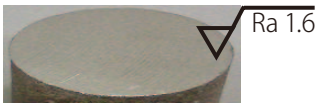


Fig. 2 Surface Polished with Milling Machine

Calibration Curve

The calibration curves for the elements in magnesium alloy are shown in Fig. 3-9. Since MnKβ overlaps and interferes with the detection of FeKα, overlap correction was set using the matrix(matricies) correction dj method (see Fig. 10). The calibration curve range, accuracy and lower limits of detection calculated from theoretical statistical variation are shown in Table 2.
For drift correction, standard sample (1) was set as the standardization sample.

Quantitative Analysis and Repeatability

The samples were quickly quench-molded from molten metal AZ91D, and then cut by milling. Table 3 shows the results of repeatability testing using five repeat quantitative analyses. The quantitative value from each analysis and the average value all satisfied the respective spec of the standard.

Table 2 Range and Accuracy of Calibration Curves and Lower Limits of Detection

	Al	Zn	Mn	Si	Cu	Ni	Fe
Calibration Curve Range (%)	0-11.67*	0-1.47	0-0.35	0-0.32	0-0.062	0-0.041	0-0.035
Accuracy (%)	0.027	0.018	0.0024	0.0094	0.00039	0.00028	0.00038
Lower Limit of Detection (%)	0.050	0.00028	0.00029	0.021	0.00040	0.00039	0.00012

* A point at the high end of the concentration range was estimated from the theoretical intensity obtained by the FP method.

Table 3 Results of Quantitative Analysis and Repeatability Tests for AZ91D Die Castings (%)

	Al	Zn	Mn	Si	Cu	Ni	Fe
1	9.21	0.777	0.2066	0.0169	0.00265	0.00118	0.00181
2	9.20	0.778	0.2065	0.0175	0.00226	0.00101	0.00174
3	9.26	0.780	0.2066	0.0174	0.00252	0.00133	0.00192
4	9.20	0.778	0.2060	0.0148	0.00253	0.00134	0.00205
5	9.24	0.777	0.2063	0.0126	0.00269	0.00104	0.00213
Average Value (%)	9.22	0.778	0.2064	0.0158	0.00253	0.00118	0.00193
Standard Deviation (%)	0.025	0.0011	0.00026	0.0021	0.00017	0.00015	0.00016
Coefficient of Variation (%)	0.27	0.14	0.13	13	6.7	13	8.3

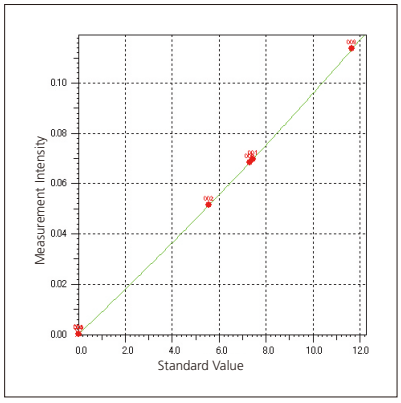


Fig. 3 Calibration Curve for Al (Kα)

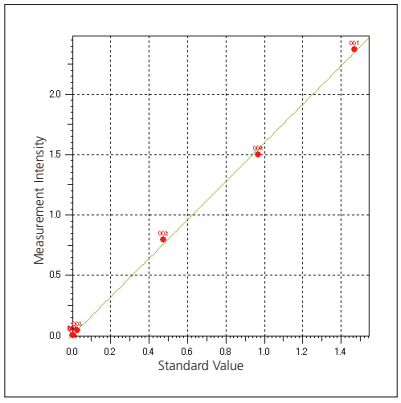


Fig. 4 Calibration Curve for Zn (Kα)

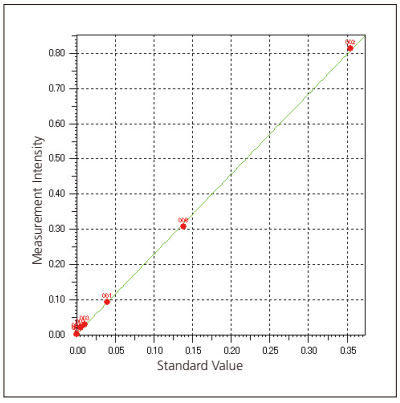


Fig. 5 Calibration Curve for Mn (Kα)

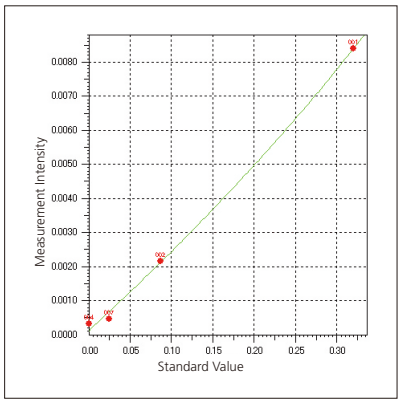


Fig. 6 Calibration Curve for Si (Kα)

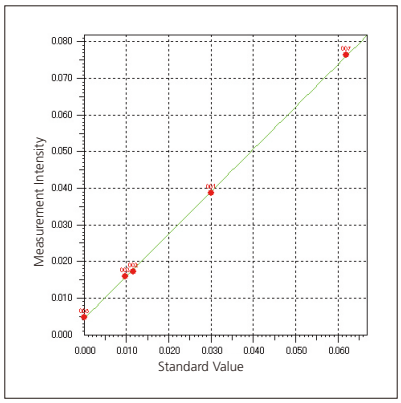


Fig. 7 Calibration Curve for Cu (Kα)

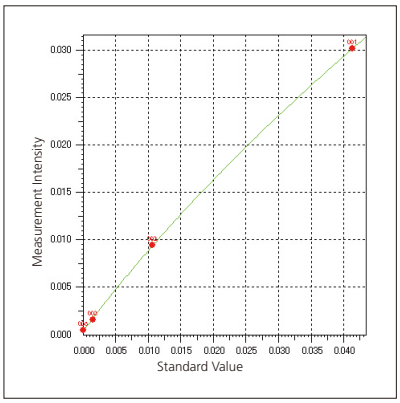


Fig. 8 Calibration Curve for Ni (Kα)

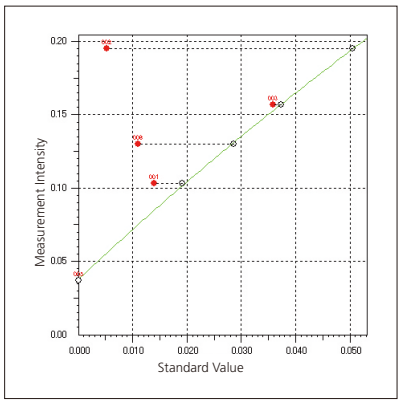


Fig. 9 Calibration Curve for Fe (Kα)
Coefficient of Overlap Correction with Mn (Kβ) 0.127168

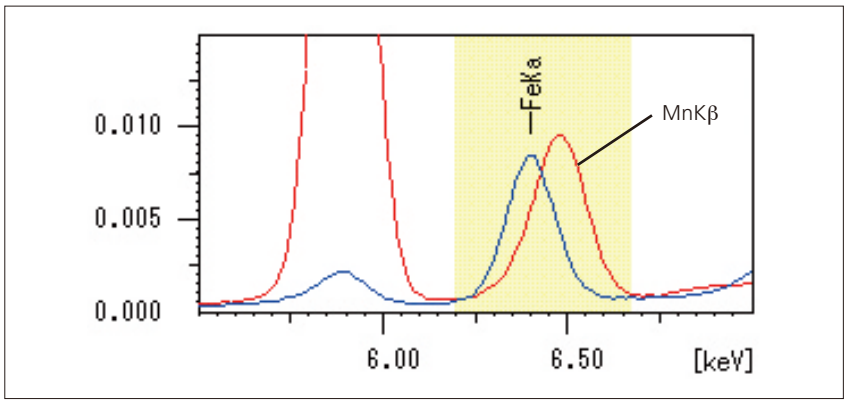


Fig. 10 Spectrum Overlap of FeKα and MnKβ
Blue: (3) 61NHR4-88; Red: (2) 65NHAZ61-Y-91 (Standard Samples)

Analytical Conditions

The Analytical Conditions are shown in Table 4. Due to the trace levels of Fe and Ni, their respective sensitivities were set to the highest level, and by conducting measurement for the other elements simultaneously with these, the total analysis time is optimized.

Table 4 Analytical Conditions

Instrument	: EDX-720
X-ray Tube	: Rh target
Filter	: #2 (Al, Si, Mn, Fe), #3 (Ni, Cu, Zn)
Tube Voltage	: 20 kV (Al, Si, Mn, Fe), 50 kV (Ni, Cu, Zn)
Tube Current	: (Auto sensitivity control) μA
Atmosphere	: Vacuum
Measurement Diameter	: 10 mmΦ
Measurement Time	: 600 sec × 2 ch
Dead Time	: Max 40 %

First Edition: June, 2012

SHIMADZU
Shimadzu Corporation
www.shimadzu.com/an/

For Research Use Only. Not for use in diagnostic procedures.
The content of this publication shall not be reproduced, altered or sold for any commercial purpose without the written approval of Shimadzu.
The information contained herein is provided to you "as is" without warranty of any kind including without limitation warranties as to its accuracy or completeness. Shimadzu does not assume any responsibility or liability for any damage, whether direct or indirect, relating to the use of this publication. This publication is based upon the information available to Shimadzu on or before the date of publication, and subject to change without notice.
© Shimadzu Corporation, 2012