SHIMADZU
Excellence in Science

Application News

No.P95

Electron Probe Microanalyzer

Aluminum Alloy Analysis

Introduction

Due to dramatic advances in science and technology in recent years, all kinds of products have become smaller and lighter. Aluminum is well known for its lightness but it also offers the properties of excellent thermal and electrical conductivity and good ductility. Due to the poor physical strength of pure aluminum, aluminum alloys that have appropriate elements added and are heat-treated to dramatically improve their strength are widely used in various products. Microstructural analysis is indispensable to control the mechanical properties, lightness, corrosion-resistance, water resistance, and machinability of these aluminum alloys. This Application News introduces the analysis of aluminum alloys by EPMA.

Aluminum Alloy Casting

AC4CH (Al-Si-Mg(Fe)) aluminum foundry alloy is widely used for automobile cast components that offer excellent mechanical strength. During the manufacture of AC4CH, spheroidization of eutectic Si particles occurs and banded structures of Mg or Fe-containing intermetallic compounds are formed at areas of eutectic melting.
In Fig. 1, the spheroidal eutectic Si is distributed in bands that partially match those at approximately 0.3 % Mg content. It is apparent that coarse intermetallic compounds, such as the 0.2 % max. Fe additive element, exist at areas of eutectic melting.

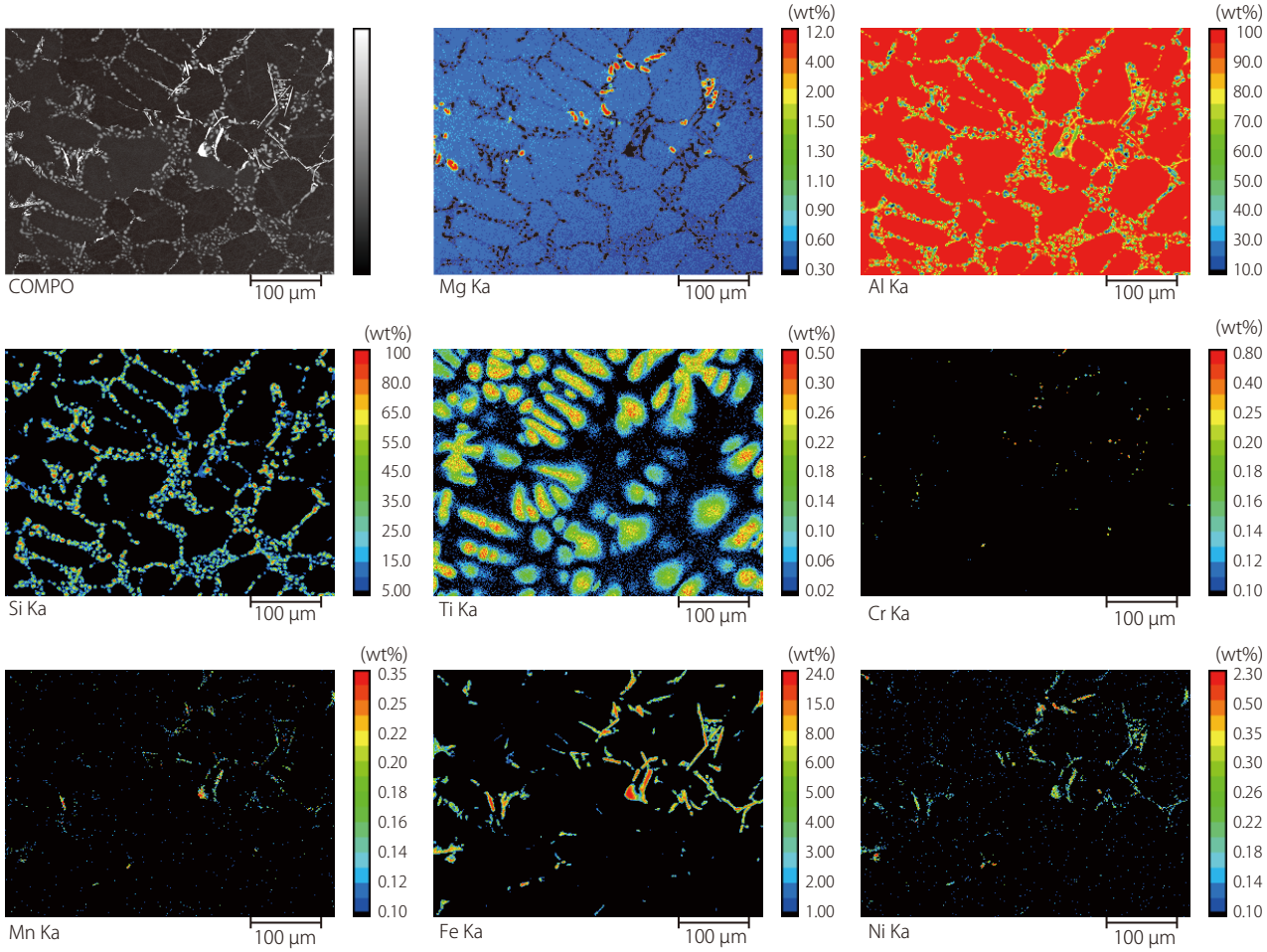

Fig. 1 AC4CH Mapping Images

Analysis of Intermetallic Compounds

The high-brightness CeB6-EPMA features a new semiconductor type back-scattered electron detector that enables high-sensitivity and high-resolution mapping at lower acceleration voltages than before. Fig. 2 shows a clear-contrast COMPO image at 10 kV acceleration voltage, even of a structure with low average atomic number. Quantitative mapping shows concentration differences for Al, Si, Mg, and Fe.

Binarization each of these four elements at their threshold value and overlaying them produces the overlay image in Fig. 2. In this overlay image, the spheroidal eutectic Si is displayed in red and Mg or Fe-containing intermetallic compounds at areas of eutectic melting are displayed in different colors depending on the composition: AlSiMgFe compounds: yellow, AlSiFe compounds: blue, and MgAlSi compounds: light blue.

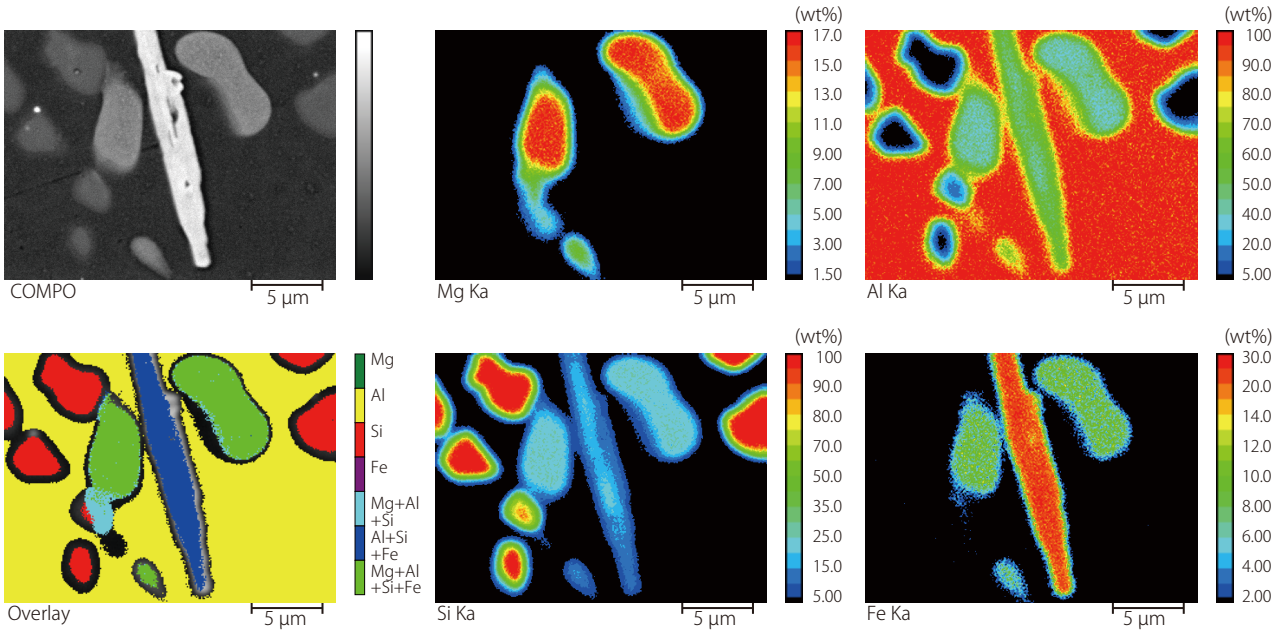

Fig. 2 X-ray Mapping and Overlay

Analysis of Trace Additive Elements

AC4CH (Al-Si-Mg (Fe)) aluminum alloy contains trace additive elements of 0.2 wt% max. Fe and 0.05 wt% max. Pb, which precipitate at high concentration in areas of eutectic melting.

For Al (92.65) Si (7) Mg (0.35), the regions of X-ray generation at 10 kV acceleration voltage are 0.42 µm for FeKα and 0.88 µm for PbMα , which match well with the element mapping image.

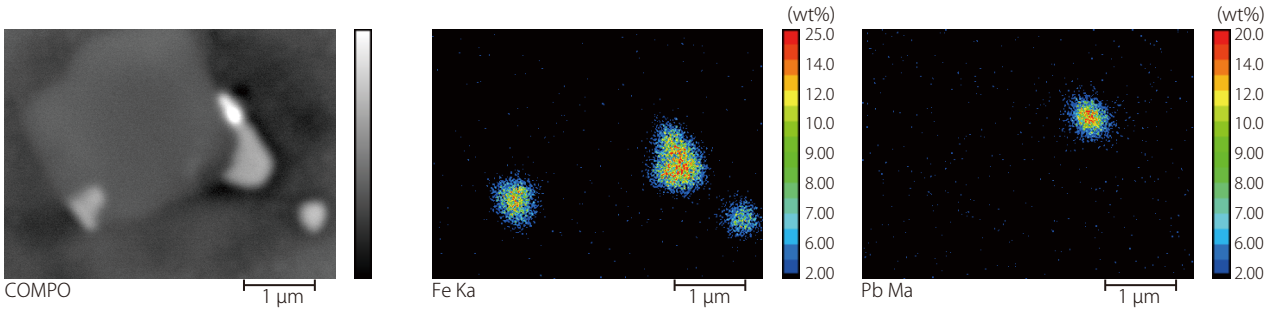

Fig. 3 Distribution of Trace Elements Added

First Edition: May. 2013

SHIMADZU

Shimadzu Corporation

www.shimadzu.com/an/