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Scanning electron microscope analysis data for casting defects in iron foundry

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Abstract

Visual and microscopic observations of the defect sites are conducted after analyzing the macroscopic information to identify the cause of cast iron defects. In addition, analysis by scanning electron microscopy (SEM) with energy dispersive X-ray analysis (EDS) has been extensively used, because SEM-EDS identification of the cause of casting iron defects. However, SEM-EDS only provides two-dimensional data in a micro area and the analysis data is affected by diffusion of the electron beam along depth of the defect sample, which may lead to a difficulty in the identification of the cause of defect formation. In this study, causes of defect formation in iron casting were investigated from several perspectives, and the samples were analyzed using metallographic observation, X-ray computed tomography (X-ray CT) observation, wavelength dispersive X-ray spectrometer (WDS), and other types of analytical equipment. Metallographic observation was used to determine the causes of the defect formation -for the graphite precipitation film in a pinhole defect, the thickness of an oxidized membrane defect, and the metallographic structure around a leak defect. Additionally, three-dimensional analysis using X-ray CT and WDS made it feasible to determine the cause of defect formation by X-ray CT and WDS by raising the assay precision of EDS.

Keywords: *Casting Iron defect, scanning electron microscopy, energy dispersive X-ray analysis*

1. Introduction

A cast iron product is required to pass checks such as visual examination, non-destructive test, microstructure observation, and leakage test. Because there are several kinds of defects and their corresponding causes, we require severak checks, wichi complicates the identification of the cause the defects, because the causes of cast defects casting plan, molding, and melting or those reciprocal actions.The effect of cast defects on factory management is substantial, therefore it is necessary to identify the cause that resulted in a cast defect. There are physical factors and chemical factors responsible for cast defect. Cast defect caused by physical factors are often revealed by the visual inspection of the outward appearance, but cast defects caused by chemical factors are minute, and therefore are difficult to identify based on the outward appearance. It is therefore effective to analyze cast defects caused by chemical factors by using SEM/EDS and taking measures. This study considered the possibility of investigating cast defects by adding microstructure observation, metallic gas analysis, and WDS to SEM-EDS.

2. Experimental Procedure

The cast defect that occurred at a cast iron manufacturing factory was used as the experimental sample. The sample was cut such that no heat was produced by friction, and the sample was analyzed using SEM-EDS. Additionally as the need arises, Microstructure observation, metallic gas analysis and WDS were conducted.

3. Results and discussion

The cast defect that occurs is different in the the material such as flake graphite cast iron and spheroidal graphite cast iron. Restrictions on the number of pages, only the results that considered dross inclusion and porosity are indicated.

Classification of dross inclusion and the results of the analysis are indicated in Fig.1. Dross is classified into oxide dross, graphite dross, and one in which the oxide and graphite dross are interminingled. Line dross and Massive dross are indicated as classification types of dross in Fig.1(A).

The shape of Line dross resembles a thin crack, as observed using SEM and metallography, and Mg, Al, and Si detect clacks on the basis of EDS, Line Dross destroyed eutectie call, as observed using metallography. On the basis of this data, it was judged that Line dross had flowed. Next, we analyzed cast defects using X-ray CT and obtained a three-dimensional image. Subsequently, the image was processed in to an image of only defect.This obtained image illustratede that Line dross resemble sheet. Line dross occurred by the oxidization of dross on the melt surface.When sheet dross is cut, it is seen as line. Line dross is flowed sheet dross made on the melt surface, therefore measures to control surplus dross ingredient and prevent melt from oxidation are imperative.

Fig1(A-2) indicates Massive dross inclusion. The shape of the dross is massive and Ba detect dross on the basis of

EDS.The dross was influenced inoculamt. Graphite was observed in flakes around dross, and around the graphite flakes were surrounded by eutectic cells of Spheroidal graphite. Consider a case where dross and iron oxide flowed, and subsequently solidify. An effective measure would be to prevent oxide formation than controlling the surplus dross ingredient.

Fig1(B) indicates graphite dross. In metallography, flowed graphite exists and poor nodularity dose no't occur under castin surface.Consider that graphite equivalent was high or temperture was low when casting.

Fig1(C) indicates the intermingled type of oxide dross and graphite dross.Dross was detected on casting sarface by SEM-EDS.Flake graphite and flowed graphite exists under the casting surface. Because, this defect is intermingled with oxide dross and graphite dross, we need to take suitable measures to prevent oxide dross and graphite dross.

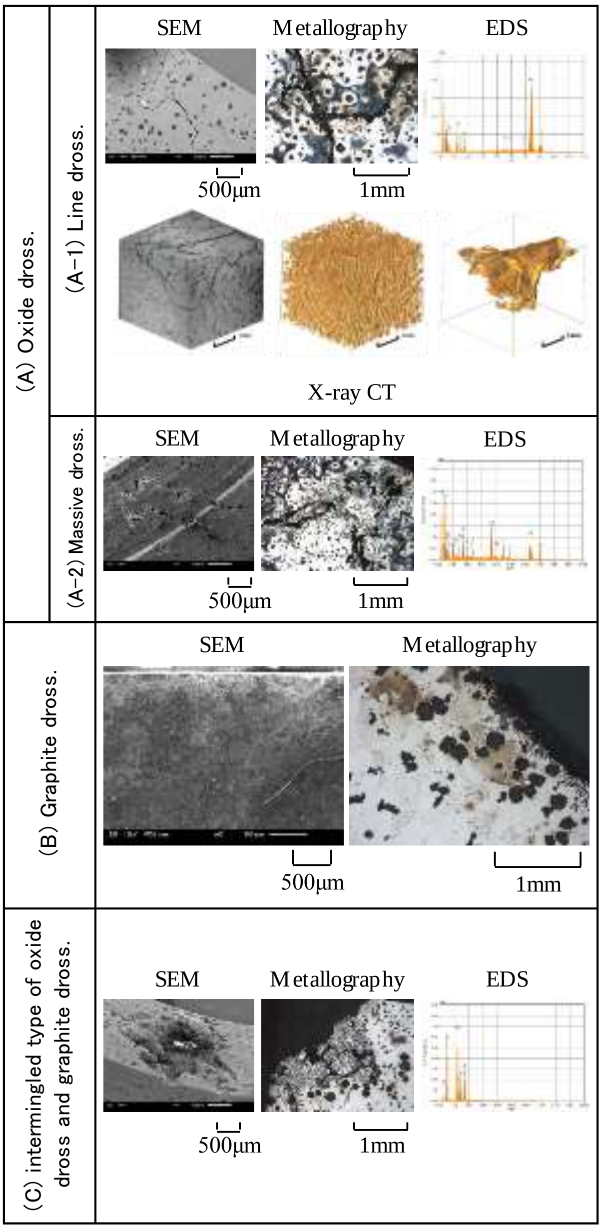


Fig1. Classification of dross inclusion and the results of the analysis

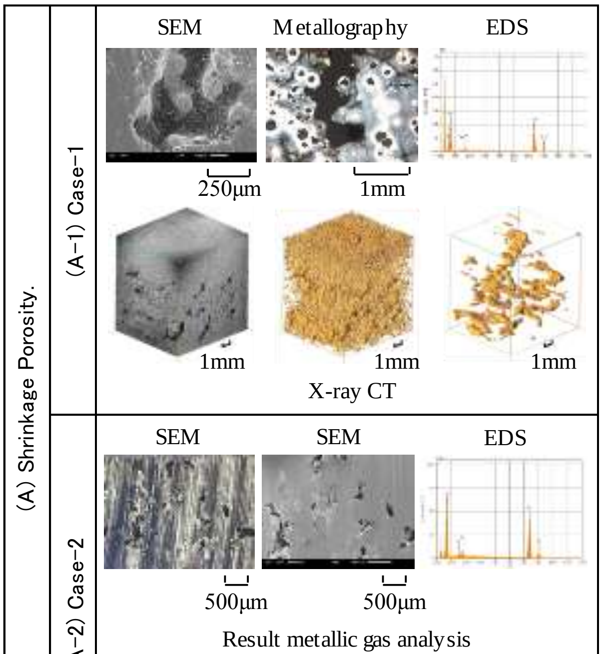
Fig2 indicates porosity defects.Fig2(A) is illustrates micro shrinkage, while Fig2(B) indivate micro porosity.

Fig2(A), the defect occurred inside the sample, around core and thickly. Dendrite and graphite were present and Mg, Ca, and O were detected to have penetrated into the defect. This porosity was surrounded by eutectic cell, wichi are a feature of porocity.Three-dimensional image indicated that porocity occurs between eutecite cells.

The defect shown in Fig2(B) occurred under the riser. The sample was analyzed to distinguish defects and non defects using metallic gas test. Large amounts of oxide were detected, and Nitrogen and Hydrogen were also present in incremented quantities in the part of defect that was analyzed.

4. Conclusion

The study showed that causes of cast defects can be identified effectively by adding data obtained from microstructure observation, metallic gas analysis and WDS to SEM-EDS.



Result metallic gas analysis

	Gas composition,ppm		
	O	N	H
Defect	186.0	61.7	4.04
Nomal	9.1	56.9	2.83

Fig2. Classification of porosity defect and the results of the analysis