The 74th World Foundry Congress 2022
16~20 October 2022, Bexco, Busan, Republic of Korea

Thermal Properties of Chill-free Ultrafine Spheroidal Graphite Iron Castings

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Abstract

Chill-free ultrafine spheroidal graphite iron sample castings were obtained using permanent mold, and their thermal properties like thermal diffusivity, thermal conductivity, and specific heat were measured. The results were compared with values by sand castings and heat-treated samples in referential data book and articles.

Keywords: SGI, Ultrafine graphite, Thermal properties

Introduction

Cast iron consists of a composite microstructure of iron matrix and graphite. The microstructure varying with chemical composition and graphite distribution makes the thermal properties change besides mechanical properties. In previous studies, thermal properties for flake graphite iron were reported mainly but those for spheroidal graphite iron were rare. This was because thermal properties of spheroidal graphite were believed to have less expectation than flake graphite iron. Therefore, they leave room for further investigation.
In this study, thermal properties were measured using sample castings of chill-free ultrafine spheroidal graphite iron, as shown in Figure 1. They were compared with existing data. As the results, points to be improved were found in previous papers. They were summarized for next studies.

Experimental Procedure

Table 1 shown chemical composition of test samples. The thickness of sample 1 has 5.4 mm, sample 2 has 15 mm and Sample 3 has 45mm. These were casted into permanent molds. Thermal diffusivity was measured by the laser flash method in the range of temperature room temperature to 873K. Specific heat was measured by the DSC method in the range of room temperature to 873K. Density was measured at room temperature by the submerged suspension method. Thermal conductivity was obtained from the relationship between thermal diffusivity, specific heat and density.

Result and Discussion

Figure 2 shows the measured thermal diffusivity of this study and previous studies [1,2,3]. And figure 3 shows the measured thermal conductivity. In the case of the results of only this study, it was observed that both measurements were larger as the wall thickness increased. It has been reported that the thermal conductivity is reduced when the Si content is high. However, when the results of this study are combined with those of the previous report, it cannot be said that this is clearly the case for the Si content in the range of addition in Spheroidal graphite iron. In addition, a comparison of the measurements from this study with those from other studies confirmed a large difference in values. This may be due to the different measurement methods. In these result, the differences in thermal properties in this studies were attributed to the ratio of pearlite and ferrite matrix in the metallurgical structure.

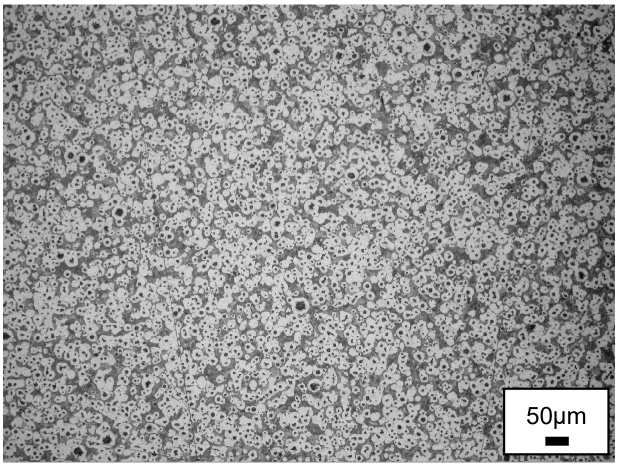

Fig.1 Microstructure of Ultrafine SGI

Table 1 Chemical Composition (mass %)

Wall thickness	*C*	*Si*	*Mn*	*P*	*S*	*Mg*
45mm	3.28	3.17	0.09	0.025	0.009	0.021
15mm						
5.4mm	3.52	3.31	0.07	0.014	0.009	0.016

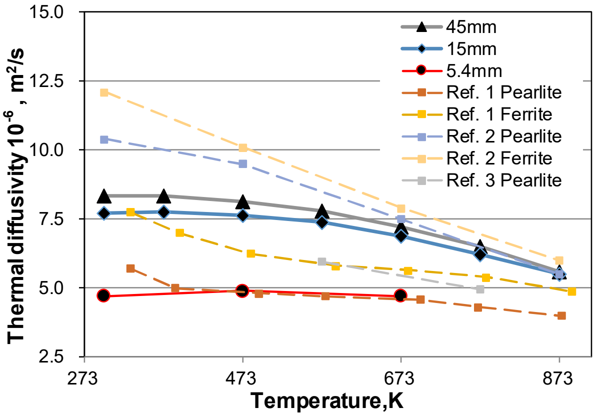

Fig.2 Thermal diffusivity of this study and previous studies

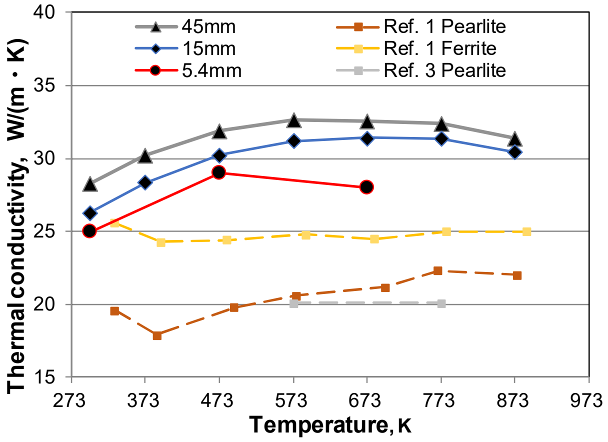

Fig.3 Thermal conductivity of this study and previous studies

Conclusion

Thermal properties of ultrafine spheroidal graphite iron castings were measured. The results obtained in comparison with previous measurements are as follows.

1. No significant difference in thermal conductivity due to Si content, in the amount of addition applied to SGI.

2. Ultrafine spheroidal graphite iron may improve thermal diffusivity and thermal conductivity with increasing wall thickness.

References

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