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Type(English)	Outline

Title:

Thermal Conductivity/Diffusivity Determination and Prediction for Iron Oxide Scale System

（鉄酸化スケールの熱伝導率/熱拡散率の決定およびその推算）

Outline:

In high-grade steel making, heat transfer characteristics of iron oxide scales formed on the slab surface are essential to obtain qualified steel. However, because of the complex structure of iron oxide scale, there are few reports focusing on the heat transfer characteristics evaluation of iron oxide scales. Thus, in the present work, the thermal diffusivity/conductivity of thermally grown FeO, Fe_3O_4 and multi-layered iron oxide scales have been determined from room temperature to 1173 K, and the values have been corrected considering the interfacial heat resistance between scale/iron and the dispersed phases of Fe_3O_4 and α-Fe. Finally, the thermal conductivity prediction equation of actual iron oxide scale was derived depending on the thermal conductivity values of each substance.

The content of each chapter is introduced as follows briefly:

Chapter 1 “Introduction”: The significance of the present study has been explained leading to the objectives of this thesis.

Chapter 2 “Temperature Dependence of Thermal Diffusivity/Conductivity of FeO Scale using Laser Flash Method”: The iron plates have been oxidised in air and then heated in a nitrogen atmosphere to obtain thermally grown FeO scales on the iron substrates. The thermal diffusivity/conductivity of the thermally grown FeO scales have been measured using the laser flash method. In addition, the temperature dependence have been clarified from room temperature to 1164 K.

Chapter 3 “Evaluation of Interfacial Heat Resistance between Iron Oxide Scale and Iron Substrate”: The interfacial heat resistances between FeO scale/Fe and multi-layered iron oxide scale/Fe have been evaluated by measuring the thermal conductivity values of scale samples with different scale thicknesses. In addition, the temperature dependence of the interfacial heat resistance between FeO scale/Fe has also been evaluated from room temprature to 1164 K. Finally, the effect of the interfacial heat resistance on the thermal conductivity/diffusivity has also been evaluated, and the thermal conductivity/diffusivity have been corrected with the interfacial heat resistance.

Chapter 4 “Effect of Transformation Behavior on Thermal Conductivity/

Diffusivity of Iron Oxide Scale”: The scale phase transformation behaviors of single FeO sample and multi-layered scale sample have been evaluated from room temperature to 1164 K with SEM-EDS analysis. The volume fractions of the dispersed Fe_3O_4 and Fe phases have been measured, and the thermal conductivity/diffusivity have been corrected with the dispersed phases. Finally, the temperature coefficients of the corrected thermal conductivity for FeO scales have been investigated.

Chapter 5 “Temperature Dependence of Thermal Diffusivity/Conductivity of Fe_3O_4 Scale Samples”: The iron plates were oxisided at 823 K in the Ar-0.84%H_2-15.6%H_2O gas to obtain Fe_3O_4 scales. The thermal diffusivity and conductivity for thermally grown Fe_3O_4 scales formed on the iron surfaces have been measured from room temperature to 1177 K. In addition, the measured thermal diffusivity/ conductivity have been corrected concerning the interfacial heat resistance and the phase change.

Chapter 6 “Thermal Conductivity Measurement and Prediction for Iron Oxide Scale”: The iron plates were oxidised in air to obtain the multi-layered iron oxide scale. The thermal diffusivity/conductivity of multi-layered iron oxide scale have been measured with the laser flash method from room temperature to 1174 K, and have been corrected with the interfacial heat resistance as described in Chapter 3. Finally, a prediction equation has been presented for the thermal conductivity evaluation of actual iron oxide scale, and the thermal conductivity of actual iron oxide scale has been calculated.

Chapter 7 “Conclusions”: Conclusions of the present thesis have been summaried.