Preface

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As the demand for high-performance steels increases every year, improving steel cleanliness is a main task of steelmakers. Nonmetallic inclusions in steel have a detrimental effect on the performance of steels, such as their strength, toughness, fatigability, cleanliness, surface finishing, castability, etc. Thus, control of inclusions is very important in the production of high-cleanliness steels. The control of inclusions usually means to control the amount, morphology, composition, and size distribution of inclusions and their spacial distribution in the steel product. Nonmetallic inclusion in steel is always a key topic for steelmaking process during the past five decades.

A wide range of operating approaches including deoxidation, calcium treatment, slag refining, and prevention against reoxidation have been applied throughout the steelmaking processes to achieve the better control of nonmetallic inclusions in steel. Firstly, accurate characterization of inclusions is required to clearly understand the source and formation mechanism of inclusions and then to find methods to remove and control them. The combination of the various methods is the best way to better understand the characteristics of inclusions. Besides, most of indigenous inclusions are produced during the deoxidation process. The Al_2O_3 -rich inclusions and Al_2O_3 -MgO spinel inclusions formed in Al-killed steels may cause defects on the surface of steel products after polishing due to their poor deformability. The nucleation, growth, fluid-flow transport, and removal of inclusions in the molten steel have been widely investigated. For the unremoved inclusions, modification treatment is necessary to make them harmless to steel. Calcium treatment was well used to modify inclusions into calcium aluminates with low melting temperature. The composition of inclusions was greatly influenced by the composition of the top slag and lining refractory materials. A lot of thermodynamic and

kinetic models have been developed to predict the formation of inclusions. Moreover, the oxide metallurgy was applied to utilize inclusion particles to improve steel properties.

Different grades of steels have different requirements of inclusions. More fundamental research is necessary to determine the target of inclusions in various types of steels. Although inclusions in the equilibrium state can be well predicted by thermodynamics, kinetic prediction is necessary to the variation of inclusions during the entire steelmaking process, especially the variation of composition and size of inclusions. During the solidification and cooling process of the steel and the heating of the steel, the equilibrium between the steel and inclusions varied with temperature, during which the evolution of inclusions needs to be investigated.

The special edition for the Journal of Iron and Steel Research International focused on nonmetallic inclusions in steel. Five articles were collected.

Sunday et al. did an extensive review on types of inclusions in steel, inclusion modification and sulfide shape control during refining in the ladle and summarized several key aspects of the metallurgy of calcium treatment and inclusion evolution during refining in the ladle; Ying and Zhang et al. performed a kinetic modeling on the reoxidation of Al-Ti-containing steel by $\text{CaO-Al}_2\text{O}_3\text{-MgO-SiO}_2$ slag and predicted the amount and composition of inclusions during refining; Joohyun et al. discussed the effect of CaF_2 content in refining slag on the formation of spinel inclusions in Ni-Cr-V-alloyed special steels; Cong et al. investigated the effect of Zr addition on the evolution of inclusions in EH36 shipbuilding steel; Qiang et al. simulated the collision and aggregation of inclusions in a turbulent fluid.

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