Preface to the Special Issue on “Fundamentals and Applications of Non-metallic Inclusions in Solid Steel”

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Non-metallic inclusions play an important role in determining the quality of steel products; thus there have been various researches to study such inclusions until now. There is already adequate knowledge about the behavior of non-metallic inclusions in molten steel and during the solidification stage. However, the effect of non-metallic inclusions on the quality of steel products is determined by its state in the final products after various thermal and mechanical treatments instead of that in the slab, bloom or billet. In many cases, the shape and/or composition of the non-metallic inclusion in the final product is not able to be prospected from that in the as cast sample. The knowledge on the behavior of steel after solidification is poor as it is an interdisciplinary area between the research field of steelmaking and forming, processing and thermomechanical treatment.

To better understand the effect of non-metallic inclusions on the quality of steel product, it is necessary to investigate the behavior of the inclusions in the product after thermal and mechanical processing, as well as their behavior in the molten steel and during the solidification stages. During the processing after solidification, various phenomena such as phase transformation of oxide, chemical reaction with solid steel, precipitation of sulfide and/or nitride on the inclusions, deformation by the rolling, can be observed.

Therefore, active researches need to focus on determining the composition and structural changes of non-metallic inclusions in solid steel at high temperature. In addition, it is essential to develop a new technique for precise analysis and evaluation of these inclusions, because their size, shape and composition are not uniform.

Based on these backgrounds, ISIJ has launched the research project entitled “Control of non-metallic inclusion properties in solid steel” in 2008. This research group consisted of 19 researchers (11 from Universities and 8 from companies) including specialists from steelmaking, thermodynamics, solidification, phase transformation, microstructures and inclusion analysis. During the 4 years activity, various pioneering studies have been achieved. Some of these achievements include measurement of thermodynamic properties in solid steel, the behavior of composition change of oxide inclusion by heat treatment, effect of inclusion on the nucleation site of phase transformation, and observation of composition difference in the cross-sectional area of fine inclusion, etc.

To summarize the activity of this research project, a special issue on “Fundamentals and Applications of Non-metallic Inclusions in Solid Steel” was planned with regard to the basic experimental studies, theoretical analyses, as well as industrial applications related to the behavior of non-metallic inclusions in solid steel, along with their evaluation. Even during the tough situation after the disaster hit Japan post-Tsunami of 11th March 2011, 19 papers were submitted not only from the domestic members of the research project but also from the overseas researchers. I hope, this special issue is useful for researchers who are engaged in the quality improvement of steel products.

Finally, on behalf of the editors of this special issue, I am grateful to all the authors for their contributions.

Fig. 1. Various research fields of non-metallic inclusions in steel.