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Effect of Magnesium Deoxidation on Non-Metallic Inclusions in Austenitic Stainless Steel

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Austenitic stainless steel (ASS) is widely utilized in various industries owing to its exceptional corrosion resistance, heat resistance, and mechanical properties. Achieving ultra-high cleanness is critical to obtaining these desirable properties. To enhance cleanness, ASS is typically produced through vacuum induction melting (VIM) and/or vacuum arc remelting (VAR) processes, with Al or Si commonly employed as strong deoxidizers. Nevertheless, non-metallic inclusion (NMI) such as alumina, spinel, and aluminosilicate form because of impurity entrainment, reoxidation of molten steel, or refractory-metal reactions during deoxidation. These inclusions can adversely affect steel productivity and quality. On the other hand, oxide metallurgy described the positive utilization of fine oxide inclusion particles to control the grain size of solidified steel. Considering both effects, it is essential to design an optimal deoxidation practice to control the number, size and phase of NMI particles.
In the current study, therefore, a magnesium (Mg), a strong deoxidizer in the form of a Ni-Mg alloy, was used to deoxidize ASS melt in an alumina crucible. The effects of Mg content on the area fraction, number density, and phase of inclusions in the molten steel were investigated. The results demonstrated that both the number density and area fraction of NMI decreased with increasing reaction time and Mg content. Moreover, the inclusion phase transition occurred from SiO_2-rich system to MgO-rich system as the Mg content increased. However, higher Mg content also led to increased Al pick-up from the alumina crucible, resulting in the formation of $MgAl_2O_4$ spinel-type inclusions through the reaction between MgO in inclusion and Al in molten steel, i.e., (MgO)inclusion+2[Al]+3[O]=$MgAl_2O_4$(s) reaction.

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