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Effect of deoxidizing elements on inclusions in vacuum refining of stainless steel

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Stainless steel is widely used in extreme environments due to its high corrosion resistance. In particular, materials for applications requiring high reliability such as medical devices and etching equipment are produced with EBM, ESR, or VAR to reduce inclusions. These processes do not use refractory materials and thus provide better cleanliness than conventional melting methods. Especially VAR provides the best cleanliness because strong carbon deoxidation occurs under its high vacuum atmosphere.

However, the factors affecting carbon deoxidation under high vacuum on the cleanliness of stainless steel have not been fully investigated. For example, the effect of the initial composition of inclusions is not well-known. Thus in this study, to evaluate the effect of initial inclusions, Si-killed and Al-killed AISI-316L steels were remelted in a high vacuum cold crucible furnace and the inclusions were investigated.

After vacuum refining, CaO-SiO₂ inclusions were observed in Si-killed material, while CaO-SiO₂-Al₂O₃ inclusions were observed in Al-killed material. Inclusion sizes were similar, despite the large difference in initial oxygen concentrations. On the contrast, number density in Al-killed material was smaller than that of Si-killed material which suggests that initial Al-killing is beneficial for higher cleanliness after vacuum refining.

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