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The Effect of Ce Content on NbC precipitate in S30432 Austenitic Heat-resistant Steel

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In order to improve the distribution of large-sized NbC aggregation in S30432 austenitic heat-resistant steel, this study systematically investigates the mechanism of modified inclusions with different Ce contents. First, the morphology, size, and distribution characteristics of NbC formed under solidification segregation were observed using SEM; further, the three-dimensional morphology of NbC precipitate was examined using a non-aqueous electrolysis method. Subsequently, the experimental analysis examined the heterogeneous nucleation of NbC by different oxide inclusions in the steel within the Ce content range of 0-0.1%. In addition, the nucleation efficiency of four types of oxide inclusions was verified through lattice mismatch calculations. Finally, the precipitation mechanism of Ce-containing inclusions was calculated using the FactSage 8.3 thermodynamic software. The results show that NbC, with sizes of several hundred micrometers, aggregates at the grain boundaries and cannot be eliminated by heat treatment; however, it can be uniformly dispersed through heterogeneous nucleation by oxide inclusions. Among them, MnCr2O4, AlCeO3, and Ce2O3 can all act as the cores for heterogeneous nucleation; however, when the Ce content is below 0.05%, the single-type inclusions in the steel are Ce2SiO5, which cannot nucleate, while composite inclusions such as MnCr2O4 can nucleate but are too few in number to effectively disperse NbC. When the Ce content exceeds 0.03%, the Ce-containing oxide inclusions transform into AlCeO3; as the Ce content continues to increase to 0.05%, the type of oxide core is modified to Ce2O3. This type of inclusion has a high nucleation efficiency and is evenly distributed in the steel, which can effectively disperse NbC.

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