The Relationship between Band Structure and MnS Inclusions in AISI 416 steel

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AISI 416 martensitic stainless steel is a sulfur-contained free-machining stainless steel grade. The element segregation in steel and the banded structure caused by MnS have a great impact on the microstructure and the mechanical property of during casting and after hot-working. This study combines the high-temperature confocal laser scanning microscopy (HT-CLSM), electron backscatter diffraction (EBSD) and electron probe X-ray micro-analyzer (EPMA) for analysis. The results show that the segregation of Cr in the ferrite leads to the transformation from chromium-rich ferrite into austenite. The aggregation of Cr elements forms segregation bands, and the segregation of C elements limits the diffusion of Cr elements. Secondly, dispersed MnS precipitates with a fine size range can not only refine the grains, but also reduce the length of the band structure, exerting the versatile role of inclusion pinning. Finally, the distribution positions of MnS between grains include intra-grain, inter-boundary and penetrating grains. The morphologies of MnS are ellipsoid, spherical and drop-shaped respectively, and the pinning force provided by spherical inclusions is greater than that of inclusions with other shapes. This work paves the way for contributing 'inclusion/precipitate engineering' concept in the development of high sulfur martensitic stainless steel.