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C-Cr-Fe-Mn-Mo-N-Ni-Si

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Ferrite/austenite duplex stainless steels are superior to austenitic stainless steels in proof strength, weldability, resistance to corrosion, and stress corrosion cracking. However, they are prone to σ phase embrittlement. In an effort to find improved alloy compositions, [1995Lee1, 2] carried out thermodynamic calculations of the equilibrium phase fractions and the driving force for σ phase formation for several candidate alloys.

Phase Equilibria in SAF2205 Duplex Steel

The SAF2205 stainless steel was treated as an eight-component system with the composition in wt.%: Fe-22Cr-5.5Ni-3Mo-1.7Mn-0.4Si-0.14N-0.02C. Sources for the thermodynamic descriptions of the binary, ternary, and quaternary systems used in the computation were listed by [1995Lee1]. The computed data include the equilibrium phase fractions as a function of temperature, the equilibrium distribution of Cr, Mn, Mo, and Ni between austenite and ferrite and the driving force for σ phase precipitation made under certain assumptions.

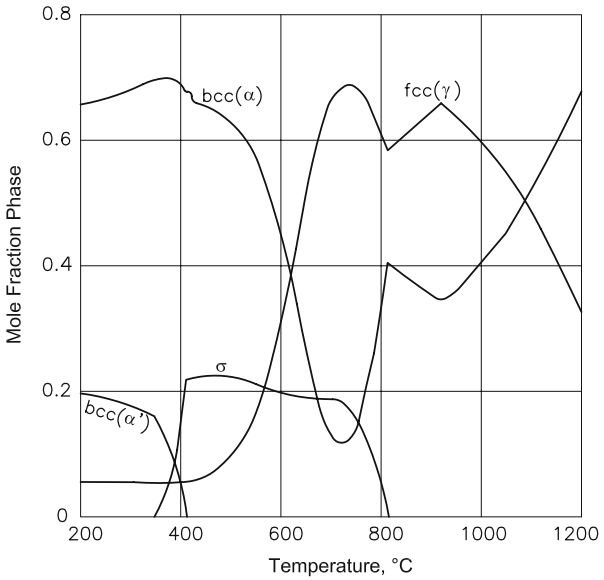

Fig. 1 SAF2205 duplex stainless steel computed equilibrium mol% of phases [1995Lee1]

In Fig. 1, the computed equilibrium phase fractions as a function of temperature are shown. Starting from the highest temperature, the austenite fraction increases with decreasing temperature with a corresponding decrease in ferrite content. Coinciding with the onset of σ precipitation at 820 °C, there is an abrupt drop in ferrite content and some increase in the austenite content. Below about 700 °C, most of austenite transforms to ferrite. Below 400 °C, the σ phase decomposes and a second ferrite phase (presumably Cr-rich) appears. Minor phases such as the Laves phase and $M_{23}C_6$, which are less than 5 mol%, are omitted in Fig. 1.

References

1995Lee1: B.J. Lee, Use of Thermodynamic Calculations for Alloy Design of Duplex Stainless Steels, in *Applications of Thermodynamics in the Synthesis and Processing of Materials*, P. Nash and B. Sundman, eds. Miner. Met. Mater. Soc., Warrendale, PA, 1995, pp. 215-230

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