Alloying Effects on Ferrite / Austenite Interface Migration in Ferrous Alloys

A systematic investigation of alloying element segregation to migrating ferrite/austenite interfaces was carried out using Atom Probe Tomography(APT). The investigation included ternary Fe-C-X (X=Mn, Si, Cr, Mo, Ni) and quaternary Fe-C-Mn-Y (Y=Si, Mo) alloys. A nitrogen based alloy, Fe-N-Mn, was also investigated. The results indicate that the interaction between C and the substitutional elements strongly affects the segregation of these elements to the interface.

The interaction of alloying elements with a moving interface has a strong influence on the interface mobility and the overall phase transformation kinetics. This is particularly the case during ferrite precipitation from austenite. In this work, high purity Fe-C-X and Fe-C-Mn-Y alloys were decarburized to produce a random ferrite/austenite interface which is moving at very low velocity. A focused ion beam microscope was used to liftout APT tips from the interface. APT testing was performed using a CAMECA local electrode atom probe operated under laser pulsing mode.

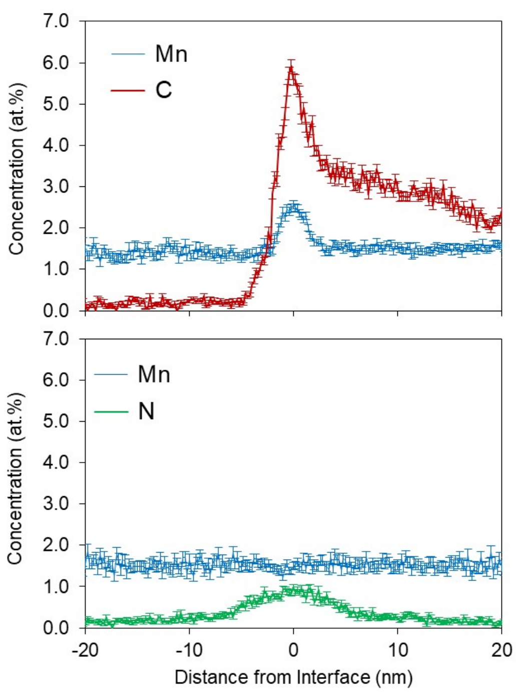

Fig. 1 Comparison of the Mn segregation to ferrite/martensite (formerly austenite) interfaces in Fe-C-Mn and Fe-N-Mn alloys [1].

Quantitative analysis of solute segregation led to several important conclusions. In particular, strong carbon segregation was reported at all interfaces. The carbon level at the interface was usually in the range of 6 to 10 at%. In contrast, weak N segregation was observed at interfaces in Fe-Mn-N. The high concentration of C at the interface along with the strong interaction of C with elements like Mn and Si, strongly influenced the segregation of these elements to the interface. In the case of Fe-C-Mn, moderate Mn segregation was observed as shown in Fig. 1. In contrast, no Mn segregation was observed in a similar Fe-N-Mn alloy under identical growth conditions. This seems to enforce the argument that Mn segregation to ferrite/austenite interfaces during ferrite growth is enhanced by the presence of C at the interface and the attractive C/Mn interaction [1]. It is speculated that the wide segregation profiles observed in Fig. 1 are partly due to the fact that Mn segregation is dominated by the interaction of Mn with C at the interface and not by the interaction of Mn with the interface itself. In the case of the Fe-C-Si system, Si segregation was not observed at the interface [2]. This is believed to be due to the strong repulsive interaction between Si and C. In the case of elements that interact strongly with the interface, such as Mo, the segregation profiles were narrower and the segregation levels were similar to those observed at grain boundaries [3].

References

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