The Effect of Co on the Deformation Response of Fe-Mn Alloys

by

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Abstract

Fe-Mn alloys are well studied and exhibit several interesting responses to deformation which lead to the possibility of desirable mechanical properties for many engineering applications. The addition of other elements to the system further improves properties and can lead to interesting effects like transformation induced plasticity, twinning induced plasticity, and the shape memory effect. Co is one such alloying agent which has seen use in several alloys which exhibit these behaviors. While Co is known to have an effect on the stacking fault energy of alloys, its precise effect on the Fe-Mn system is somewhat less explored. This study seeks to understand what effect Co has on the Fe-Mn system in terms of its effect on thermodynamic properties, phase composition, deformation induced phase transformation, and mechanical properties. Using a thermodynamic model, three alloys of varying Co concentration with a fixed Fe:Mn ratio of 4 were selected for study to systematically examine the effect that Co has on their response to deformation. An additional alloy of equiatomic composition was created as a basis of comparison. X-ray diffraction, scanning electron microscopy, and microhardness testing were used for evaluation. It is seen that Co has a somewhat complicated effect on the deformation behavior of Fe-Mn alloys. In all alloys, $\gamma \rightarrow \varepsilon$ martensitic transformation occurs. At concentration below 8 at. % Co, increased α' martensite formation within the ε-phase is observed. Possible causes of α' formation within the ε-phase and the effect on microhardness are explored. At concentrations of 8 at. % Co, the ε-phase seems to be stabilized and only $\gamma \rightarrow \alpha'$ transformation is observed. The equiatomic alloy exhibits only $\gamma \rightarrow \varepsilon$ transformation. Several examples of deformation twinning are shown. The thermodynamic model has good agreement with experimental results at low Co concentration, but seems to break down when used for the equiatomic alloy.