Exploring bainite : origin of the barrier, carbon supersaturation and the impact of deformation

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Abstract

Bainite plays a crucial role in the microstructural evolution of many steels, significantly influencing their mechanical properties [1-2]. Despite extensive research over the years, several questions about bainite remain unresolved. One such question concerns the behavior of carbon during the transformation, with ongoing debate between those who support a diffusionless process and those who believe carbon diffusion drives the transformation [1]. Additionally, the impact of deformation on bainitic transformation has long intrigued scientists [2-3]. This presentation offers a thorough exploration of bainitic transformation by integrating both theoretical models and experimental findings.

We begin by examining the traditional Zener-Hillert model, which predicts the diffusion-controlled growth of bainitic ferrite but often underestimates growth rates compared to experimental data. We introduce a modified model incorporating a physics-based barrier energy, addressing these discrepancies by accounting for disconnections at the interface and their interactions with matrix defects [4].

Additionally, we address a crucial observation: partial carbon supersaturation in bainitic ferrite at lower temperatures, which conventional equilibrium based models fail to predict due to the assumption of local carbon equilibrium. By relaxing this assumption, our revised model

accurately reflects carbon activity differences between austenite and bainite, enhancing predictions of carbon content and growth kinetics [5].

We also investigate the impact of deformation on bainitic transformation under two conditions: pre-deformation (ausforming) and simultaneous deformation with transformation. Our results reveal that ausforming enhances nucleation and refines the microstructure, while simultaneous deformation increases the growth rate of bainitic ferrite. The modified Zener-Hillert model explains these effects by incorporating deformation's impact on dislocation behavior and growth dynamics [6].

References

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