EFFECT OF 30 T MAGNETIC FIELD ON PHASE TRANSFORMATIONS IN A BAINITIC HIGH STRENGTH STEEL

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Introduction

Recently, the effect of a 30-tesla magnetic field on phase transformations in a high-carbon bainitic alloy was evaluated [1] while continuously cooled at a rate of 1 °C/s. In this work, additional research has been performed to understand the alloying element partitioning characteristics during the pearlite formation. Moreover, the tendency for the pearlite formation under isothermal conditions with and without magnetic field was evaluated.

Experimental

In this study, two steels (see Table 1) were used. The steel identified as "SK" exhibits very sluggish transformation kinetics. In contrast, the steel identified as "FK" is alloyed with Co and Al to enhance the transformation kinetics.

Table 1. Compositions of steel used in the current investigation in at.%

Alloy	C	Si	Mn	Mo	Cr	Co	Al	V	Fe
SK	3.34	3.10	1.89	0.16	1.52	-	0.02	0.10	Balance
FK	3.43	3.01	1.94	0.13	1.03	3.47	2.68	-	Balance

A 32 mm diameter bore resistive magnet with maximum field strength of 33-Tesla at the National High Magnetic Field Laboratory (NHMFL) was used.

Results and Discussion

The SK and FK steels subjected to continuous cooling from austenitizing temperature without magnetic field did not show any major differences in the microstructure [Fig. 1*a* and 1*b*]. On application of a 30- tesla magnetic field, the SK steel showed some localized regions of softer microstructure [Fig. 1*c*]. In contrast, the FK steel with an applied magnetic field led to a uniform soft microstructure [see Fig. 1*d*].

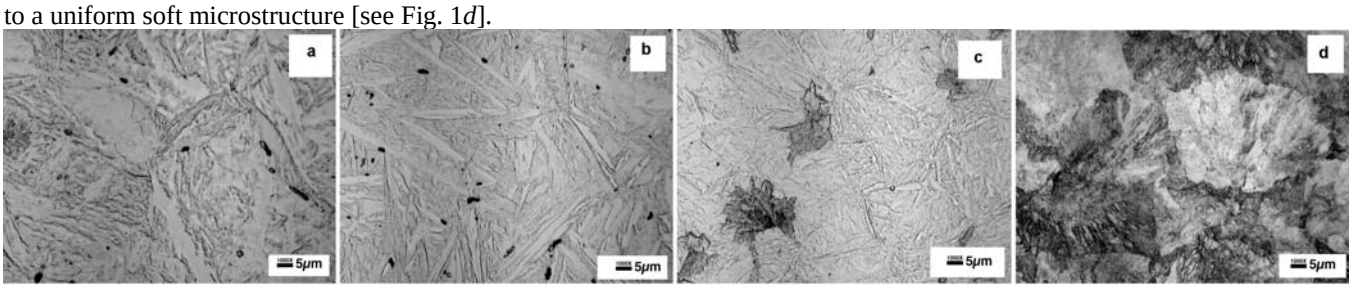

Figure 1. Summary of microstructures attained by continuous cooling from austenitizing temperature with and without magnetic field: (*a*) SK steel – No field; (*b*) FK steel – No field; (*c*) SK steel – 30 tesla; and (*d*) FK steel – 30 tesla.

Conclusions

Although all of the results of this study are not presented here, this research investigated the effects of 30- tesla magnetic field on the austenite decomposition in two high-carbon steels with different austenite decomposition kinetics. In the steel alloyed with Al and Co, the decomposition of austenite to fine pearlite occurred while continuously cooling from austenite phase field. The pearlite microstructure exhibited a lamellar spacing of less than 50 nm. Atom probe analysis of this pearlite showed enrichment of Cr, Mn, and C and depletion of Si, Al and Co in the cementite phase. The decomposition of austenite was not extensive during continuous cooling in the alloy without Al and Co due to the sluggish kinetics.

References

[1] Jaramillo, R.A., *et al*., Scripta Materialia, **52**, 461-466 (2004).