Effect of grain boundary character distribution and grain boundary phosphorus segregation on the brittleness of an interstitial-free steel

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Effect of grain boundary character distribution and grain boundary phosphorus segregation on the brittleness of an interstitial-free steel

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Abstract: Grain boundary character distribution and grain boundary P segregation in an interstitial-free steel annealed for up to 4h at 700°C after cold rolling are investigated using electron backscatter diffraction and Auger electron spectroscopy. During annealing, the recrystallized grain size and hardness of the steel do not change apparently, being ~10μm and 90HV, respectively, but the number percentage of random high-angle grain boundaries initially increases with increasing annealing time until reaching a maximum at 3h and then decreases slightly after that. The random high-angle grain boundaries play an important role in the steel embrittlement. Both P grain boundary segregation and ductile-to-brittle transition temperature (DBTT) of the steel increase in the same trend with increasing number percentage of random high-angle grain boundaries. The relationship between DBTT and P boundary concentration (C_p) is linear, being expressed as DBTT(°C)=3.12C_P−118.87 (C_p, at.%), showing that the annealing treatment of cold-rolled interstitial-free steel should be precisely designed to avoid embrittlement.

Keywords: Grain boundary character distribution; Grain boundaries; Segregation; Embrittlement; Interfaces

1. Introduction

Interstitial-free (IF) steel, with perfect deep drawing performance, has been widely used in the manufacture of stamping parts with complicated shapes. Practice shows that the thin steel sheet with desirable mechanical properties can be acquired through hot rolling in the austenite temperature range and cold rolling in the ferrite range, followed by suitable annealing [1,2]. In fact, the

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