



## Microstructures, mechanical properties and deformation of near-rapidly solidified low-density Fe-20Mn-9Al-1.2C-xCr steels



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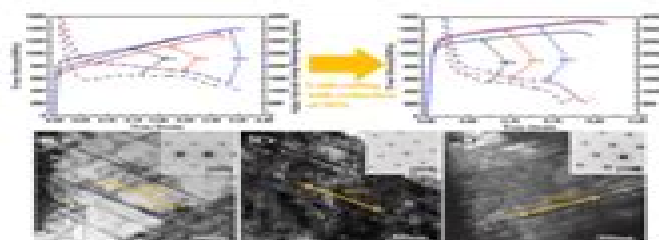
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### HIGHLIGHTS

- Cr addition increases  $\delta$ -ferrite content and decreases nano-scale  $\epsilon$ -carbide content in low-density Fe-20Mn-9Al-1.2C steel.
- The decrease of nano-scale  $\epsilon$ -carbide promotes generation of the slip bands and increases its strain hardening rate.
- A double (Slip-band and Microband) hardening mechanism is proposed for strain hardening of the low-density steel strips.

### GRAPHICAL ABSTRACT



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### ABSTRACT

The effects of Cr addition on microstructures, mechanical properties and deformation behavior of near-rapidly solidified low-density Fe-20Mn-9Al-1.2C (wt. %) steel strips were investigated. It was found that Cr addition increased the volume fraction and size of  $\delta$ -ferrite, and decreased the precipitation of  $\epsilon$ -carbides in this low-density steel strip. The yield strength of the near-rapidly solidified steel strips was decreased significantly, but the ultimate tensile strength and the total elongation didn't obviously change. However, after cold rolling with 20% reduction, the yield strength and ultimate tensile strength of Cr-containing steel strips were significantly higher than that of the Cr-free steel strip. It was attributed to the fact that the decrease of  $\epsilon$ -carbides caused by Cr addition facilitated the formation of high-density slip bands during cold rolling deformation. The ultimate tensile strength and total elongation of cold-rolled 9Cr (wt. %) steel strip were 1270 MPa and 21%, respectively. A double (Slip-band and Microband) hardening mechanism was proposed for the strain hardening behavior of the low-density steel strips, and the number of nanoscale  $\epsilon$ -carbides played a crucial role in the strain hardening rate at the early strain stage.

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### 1. Introduction

Due to increasingly rigorous demands of energy conservation and emission reduction, the Fe-Mn-Al-C steel with the excellent mechanical properties and low density has extensive attention in the automotive field [1–4]. According to the constitution phase, Fe-Mn-Al-C steel is

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