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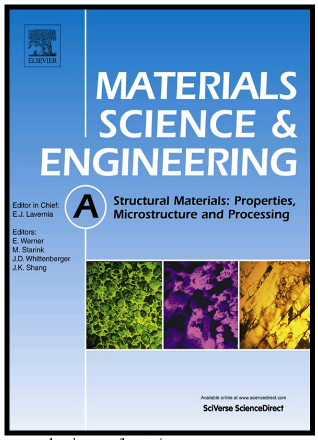

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Influence of Microstructure and Pre-straining on the Bake Hardening Response for Ferrite-Martensite Dual-Phase Steels of Different Grades

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Abstract: This work aims to investigate the effects of pre-straining and microstructure on bake hardening (BH) response of dual phase (DP) steels. Four kinds of different grades of commercial DP steels, DP340/600, DP420/780, DP500/780 and DP550/980, were pre-strained in tension to 0.5, 1, 2, 4, 6 and 8%, then baked at 170 °C for 20 min followed by restraining, or just baked at 170, 190, 210, 230, 250 °C for 20 min and at 250 °C for 40 min followed by straining without pre-straining. Electron backscattered diffraction (EBSD) measurements and temperature-dependent internal friction measurements were conducted to characterize geometrically necessary dislocations (GNDs) and analyze solute carbon content and interactions between point defects and dislocations in DP steels. The results show that for all grades of DP steels investigated, BH values increase to peak values at pre-straining ranging from 0.5 to 2% and then decline with further pre-straining. At BH condition of 170 °C/20 min, peak BH values with pre-straining are 33 MPa for DP340/600, 34 MPa for DP420/780, 78 MPa for DP500/780 and 90 MPa for DP550/980 respectively. Pre-straining can cause increase in tensile strength and decrease in total elongation after baking, especially for DP500/780 and DP550/980. DP steels without pre-straining can reach very high BH_0 values by applying either higher temperature or longer holding time. Solute carbon content in ferrite controls the speed of BH response in DP steels. Microstructures of higher volume fraction of martensite, smaller martensite islands and smaller ferrite grains can produce higher BH values.

Keywords: Bake-hardening; Dual-phase steel; Geometrically necessary dislocation; Internal friction

1. Introduction

Advanced high strength steels (AHSS) have been increasingly used in automotive industry for the purpose of weight saving and crash safety improving of vehicles. As the first generation of AHSS, dual phase (DP) ferrite-martensite steel presents unique combination of high strength and good formability and its special mechanical properties can be tailored and adjusted by alloying and processing with respect to the requirements of specific structural application for auto-body, which offers promising application prospect [1-4].

The microstructure of DP steel consists of hard martensite particles dispersed in a soft and ductile ferrite matrix [5]. This combined microstructure gives DP steel some interesting properties such as combination of high strength and good ductility, continuous yielding, high initial work-hardening rate (*n* value) and a low ratio of yield stress to tensile strength (YS/TS) [6]. Furthermore, the continuous yielding behavior, no yield-point elongation, makes the absence of Lüders bands during plastic flow of DP steel,

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