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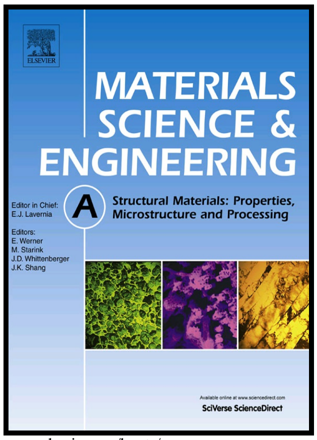

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STABILITY OF GRAIN-REFINED REVERSED STRUCTURES IN A 301LN AUSTENITIC STAINLESS STEEL UNDER CYCLIC LOADING

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Abstract

Austenite stability against the deformation induced α'-martensite (DIM) formation and the cyclic deformation behavior of grain-refined structures with the grain size between 13–0.6 µm under fatigue loading were investigated in a 301LN Cr-Ni austenitic stainless steel. The DIM transformation in the course of cycling at constant total strain amplitudes of 0.4% and 0.6% was recorded by magnetic measurements and microstructures examined by electron backscatter diffraction and X-ray diffraction. The cyclic deformation behavior was followed by the evolution of the stress amplitude. The results evidenced that the austenite stability increases with the decreasing average grain size down to about one micrometer, obtained in annealing at 900°C for 1 s. On the contrary, the stability decreases drastically in the submicron, non-homogeneous grain structures created at the lower temperatures of 800–700°C. In these structures, submicron grains seem to be stable, and the precipitation of CrN is considered to contribute to the reduced stability of grains with a few-micron-size present among submicron grains. Under cyclic loading, the level of initial stress amplitude varied considerably in dependence on the refined austenite grain size. At the 0.6% strain amplitude, the initial softening was followed by cyclic hardening. The level of the final stress amplitude was related to the fraction of DIM formed during cycling straining.

Keywords: austenitic stainless steel, reversion treatment, grain size, strain-controlled fatigue, deformation induced martensite transformation, cyclic behavior

1. INTRODUCTION

The stability of austenite phase during plastic deformation plays a significant role in various steels as regards as their strength and ductility. The deformation-induced transformation of austenite to martensite, the transformation-induced plasticity (TRIP) effect, can be utilized in modern carbon steels as well in metastable austenitic stainless steels, e.g. [1–4]. The austenite stability is mainly influenced by the chemical composition and temperature, but also by other microstructural factors such as crystallographic orientation, defect density, surrounding phases, and grain size (GS), e.g. [4, 5].

Stainless steels can be used in automotive industry to reduce weight and cost in the manufacture of motor vehicles and to improve safety and sustainability in automotive body structures, for instance in bus structures, tank trucks and trailers, etc. In moving vehicles fatigue strength becomes important in addition to static one. New nano-