



The influence of reversion annealing behavior on the formation of nanograined structure in AISI 201L austenitic stainless steel through martensite treatment

A. Rezaee*, A. Najafzadeh, A. Kermanpur, M. Moallemi

Department of Materials Engineering, Isfahan University of Technology, Isfahan 84156-83111, Iran

ARTICLE INFO

Article history:

Received 22 November 2010

Accepted 27 March 2011

Available online 31 March 2011

Keywords:

A. Ferrous metals and alloys

C. Heat treatments

F. Microstructure

ABSTRACT

Martensite treatment is one of the known thermo-mechanical processes that can be used for the grain refinement of metastable austenitic stainless steels. In this work, the martensite to austenite reversion behavior as well as its effect on the processing of nanocrystalline structure in an as-cast AISI 201L austenitic stainless steel was investigated. The as-cast specimens were first homogenized and then hot forged in order to prepare a suitable microstructure for the subsequent martensite treatment. The cold rolling was carried out to various reductions between 10% and 95% followed by annealing at temperature range of 750–900 °C for different times of 15–1800 s. The microstructure characterization was performed using optical and scanning electron microscopies, X-ray diffraction and Feritscope. Hardness measurements were also used for evaluating the mechanical properties of the experimental material. The results indicated that the specimen which was reversion-annealed at 850 °C for 30 s exhibited the smallest average austenite grain size of 65 nm with more than 86% austenite.

© 2011 Elsevier Ltd. All rights reserved.

1. Introduction

In recent years, there is a growing interest in developing the third generation of advanced high strength steels, including stainless steels, for light weight constructions. These steels can possess nano/ultrafine grained microstructures with an excellent combination of strength and ductility [1]. Since austenitic stainless steels (ASSs) do not undergo any transformation during the hot deformation, the grain refinement may be achievable only through the occurrence of recrystallization in the microstructure [2]. According to the literature, the level of grain refining achieved via these processes is very limited (about 5 μm) [3]. An effective route to fabricate ultrafine grained metastable ASSs is called martensite treatment. This process involves heavy cold rolling to form strain induced martensite (SIM) from austenite, following by the reversion of this martensite again to the austenite upon annealing at relatively low temperatures for short durations [4,5].

Metastable ASSs have low stacking fault energy [6], and thus bundles of faults readily form during cold deformation. The strain induced nucleation of α -martensite primarily occurs at slip bands and is associated with a high density of dislocation pile-ups [7]. Talonen and Hanninen [7] observed that the intersection of hexagonal close-packed shear bands and stacking faults act as nuclei for martensite and the formation of shear bands is a precursor for SIM development. To produce SIM, straining must be applied above the

martensite start temperature (M_s), but below the M_d temperature which is defined as the minimum temperature above that no martensite will form under any condition [8]. It should be noted that the martensite fragmentation during deformation produces a large number of crystal defects in the structure and provides nucleation sites for austenite during reverse transformation, leading to noticeable grain refinement [9].

Depending on the annealing temperature, the induced martensite phase can be metastable and its reversion into the austenite may occur in two ways, namely, the athermal shear and the isothermal diffusional mechanisms [10]. As is well established, the reversion of martensite in the microstructure of ASSs takes place at a temperature (around 750 °C) much lower than the recrystallization temperature of the alloy [11].

Up to now, grain refining potential in the conventional 300 series ASSs has been extensively studied [11,12] while very few investigations have been conducted on obtaining nano/ultrafine grained structures in 200 series ASSs. AISI 201L steel is an austenitic grade which exhibits high work hardening rate and low stability against the SIM. The aim of the present work is to investigate the influence of the reversion annealing behavior on the formation of nanocrystalline 201L ASS through martensite treatment.

2. Materials and methods

Cast ingots of AISI 201L steel were prepared using an induction furnace under the air atmosphere. The chemical composition of the experimental steel is listed in Table 1. In order to decrease the

* Corresponding author. Tel.: +98 3113914496; fax: +98 3113912752.

E-mail address: a.rezaee@ma.iut.ac.ir (A. Rezaee).