Advances in Materials Research, *Vol.3, No.4 (2014) 217-225*
DOI: http://dx.doi.org/10.12989/amr.2014.3.4.217

Dynamic recrystallization and microstructure evolution of a Nb-V microalloyed forging steel during hot deformation

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(Received June 17, 2014, Revised December 22, 2014, Accepted December 27, 2014)

Abstract. In this study, a forging steel alloyed with both Nb and V was used as experimental material and the hot deformation behavior has been studied for this steel by conducting the compressive deformation test at temperature of 900-1150 °C and strain rate of 0.01-10 s^{-1} in a MMS-300 thermo-mechanical simulator. The microstructure evolution, particularly the dynamically recrystallized microstructure, of the experimental steel at elevated temperatures, strain rates and strain levels, was characterized by optical microstructural observation and the constitutive equation in association with the activation energy and Zener-Hollomon parameter. The curves of strain hardening rate versus stress were used to determine the critical strain and peak strain, and their relation was connected with Zener-Hollomon parameter. Under the conditions of processing temperature 900 °C and strain rate 0.01 s^{-1}, the dynamic recrystallization took place and the austenite grain size was refined from 164.5 μm to 28.9 μm.

Keywords: Nb-V microalloyed forging steel; dynamic recrystallization; microstructure evolution; constitutive equation; activation energy

1. Introduction

Microstructural control of metallic materials during hot working is an important key during thermomechanical processing since it allows to control the final microstructure and in turn the desired mechanical properties of the metals and alloys (Mejía 2011). Dynamic recrystallization (DRX) is the most important mechanism to control the microstructure, which can give rise to the refinement of microstructure and flow stress reduction. Therefore, understanding of the DRX behavior in the hot working of metals and alloys will be helpful to determine the optimal processing parameters (Liu 2013).

Microalloyed forging steels are widely used in manufacturing components and parts in automobile and machinery industries due to cancellation of quenching and tempering treatment. The conventional processing technology for microalloyed forging steels is hot deformation at elevated temperature, e.g. forging or rolling, and subsequently controlled cooling. So, the hot

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http://www.techno-press.org/?journal=amr&subpage=7 ISSN: 2234-0912 (Print), 2234-179X (Online)

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