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A study of dynamic recrystallization behavior depending on precipitate size in Nb micro-alloyed low carbon steels

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The dynamic recrystallization behavior depending on precipitate size was investigated by measuring the size of the precipitate and the recrystallization starting time. The chemical composition of steels was 0.07C-1.2Mn-0.15Si-0.03Nb (wt%). The precipitated fraction was fixed to 100% and the precipitate size was maintained during experiment. Also after completion of the precipitation, the precipitate was not dissolved. The hot compression test was analyzed by thermodynamic s/w (THERMO-CALC), microscope and image analyzer.

KEYWORDS : Nb micro-alloyed steel, Dynamic recrystallization, Hot deformation, Precipitate

1. Introduction

The fine grain structure is the most effective way to improve both strength and ductility in steels. During the hot working, recrystallization behavior of Nb micro-alloyed steels is inhibited or stopped by pinning effect of precipitate. The pinning force is inversely proportional to the size of the precipitate. This effect was not easy to deal in that quantitatively measuring the size of the precipitate is very difficult up to now.

2. Experimental procedure

The chemical composition of steels was 0.07C-1.2Mn-0.15Si-0.03Nb (wt%). After solid solution heat treatment at 1,200 °C for 15 min, the specimens were austenitization at 950 °C. And then heat treatment at 950 °C for 4×10^4 sec and at 650 °C for 10^5 sec respectively in order to get a different size of precipitates. For high-temperature compression test, after austenitization at 1,000 °C during 10 min. The applied strain was 1.2 and strain rate was 0.01/sec.

3. Results

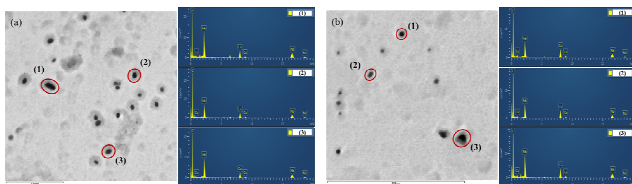


Fig. 1 EDS analysis of chemical composition of precipitates with (a) 4×10^4 sec holding at 950 °C, (b) 10^5 sec holding at 650 °C

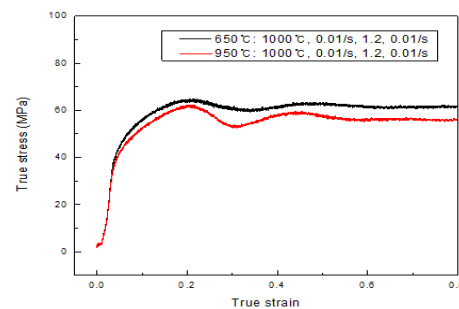


Fig. 2 Flow curve by different size of precipitate in Nb micro-alloyed steels

4. Conclusions

The average size of the precipitates which were formed in austenite region was bigger around one and half times as much as formed in ferrite region by heat treatment experiment. In dynamic recrystallization behavior critical time were 828s at 950 °C and 830s at 650 °C respectively by the flow curve. The size of precipitates has an effect on pinning force which is affect recrystallization kinetics.

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