World Academy of Science, Engineering and Technology
International Journal of Materials and Metallurgical Engineering
Vol:10, No:10, 2016

Grain Growth Behavior of High Carbon Microalloyed Steels Containing Very Low Amounts of Niobium

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Abstract : This study aimed for understanding the effects of dilute Nb additions on the austenite microstructure of microalloyed steels at five different reheating temperatures from 950 °C to 1300 °C. Four microalloyed high-carbon steels having 0.8 %wt C were examined in which three of them had varying Nb concentrations from 0.005 wt% to 0.02 wt% and one of them had no Nb concentration. The quantitative metallographic techniques were used to measure the average prior austenite grain size in order to compare the grain growth pinning effects of Nb precipitates as a function of reheating temperature. Due to the higher stability of the precipitates with increasing Nb concentrations, the grain coarsening temperature that resulted in inefficient grain growth impediment and a bimodal grain distribution in the microstructure, showed an increase with increasing Nb concentration. The respective grain coarsening temperatures (T_GC) in an ascending order for the steels having 0.005 wt% Nb, 0.01 wt% Nb and 0.02 wt% Nb were 950 °C, 1050 °C and 1150 °C. According to these observed grain coarsening temperatures, an approximation was made considering the complete dissolution temperature (T_DISS) of second phase particles as T_GC=T_DISS-300. On the other hand, the plain carbon steel did not show abnormal grain growth behaviour due to the absence of second phase particles. It was also observed that the higher the Nb concentration, the smaller the average prior austenite grain size although the small increments in Nb concenration did not change the average grain size considerably.

Keywords : microalloyed steels, prior austenite grains, second phase particles, grain coarsening temperature
Conference Title : ICMSMNM 2016 : International Conference on Metallurgical Science, Micro and Nano Materials
Conference Location : Seoul, Korea, South
Conference Dates : October 06-07, 2016