8th International Conference on Physical and Numerical Simulation of Materials Processing (ICPNS)

14–17 October 2016

Seattle, Washington | Hosted by Purdue University

SESSION 4: WELDING AND COATING, SALON E

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SATURDAY, OCTOBER 15, 2016

The influence of welding thermal cycle on microstructure and mechanical properties for 9Cr2WVTa steel

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ABSTRACT

The microstructures and mechanical properties of heat affected zones (HAZs) by gas tungsten arc welding (GTAW) were studied for 9Cr2WVTa steels. Enlarged HAZs samples with 8–10 mm wide uniform temperature zone were prepared by the thermal–mechanical physical simulator Gleeble 1500 based on the finite element method (FEM) numerical simulation and experimental measurement for the welding thermal cycle process and weld profile. Typical welding thermal cycle curves were extracted based on the measurement of the non-equilibrium phase transformation of 9Cr2WVTa steel, and the simulated and experimental thermal cycles were compared. Observation of the microstructure revealed that the blocky δ-ferrite that existed in the coarse grained heat affected zone (CGHAZ) was the main cause of the decrease in impact toughness. Each of the areas retained the δ-ferrite with different sizes and shapes after the CGHAZ underwent the second welding thermal cycle. Hardness tests, tensile tests, and instrumented impact tests were carried out to investigate the corresponding mechanical properties. When the peak temperature of the second welding thermal cycle was 1315°C, grain and structure coarsening was the main causes of the decrease in impact toughness. When the peak temperature of the second welding thermal cycle was decreased to 1100°C, the toughness increased the most due to the fine grains formed by phase transformation recrystallization.

KEYWORDS: physical and numerical simulation, 9Cr2WVTa steel, welding thermal cycle, delta ferrite, grain and structure coarsening, phase transformation recrystallization