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Investigation of the susceptibility of cast superalloy K438 to liquation cracking during welding through Gleeble thermo-mechanical simulation testing

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ABSTRACT

Gleeble thermo-mechanical simulation testing was conducted to evaluate the susceptibility of cast superalloy K438 to liquation cracking during welding, and it was found to be of great limitation to use this evaluation method for cast superalloys with ultra-low hot ductility. The measurable parameters were extracted from the Gleeble test, and the variation laws and characteristics of them during the test were investigated; then, it was discovered that the tensile breaking force and stroke can manifest indirectly the metallurgical change of alloy K438 during thermal cycles and so they can take the place of percentage reduction of area to be used as parameters in the evaluation of susceptibility to liquation cracking. Moreover, the tensile breaking force is more sensitive than the stroke in capturing the difference caused by the variation in materials and process. It was also shown through the comparison of breaking force curves that the alloy in homogenization treated state is less susceptible to liquation cracking than that in solution treated one. In addition, the effect of the rate of thermal cycle was revealed, and it was shown that there is some rate to achieve the minimum tensile breaking force for alloy in either state. Finally, the relations between the variation of tensile breaking force in response to the rate of thermal cycle and the liquation behavior were discussed in combination with SEM analysis of the fracture surface and microstructure.

KEYWORDS: cast superalloy, weld, liquation cracking, thermo-mechanical simulation testing