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Stray Grain Formation in Nickel-Base Superalloy Single-Crystal Welds*

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During the welding of nickel-base superalloys, it is desirable to maintain the single crystal nature of the base material in the weldments. Stray grain formation during solidification destroys the single crystal structure and compromises properties. In addition, weld cracks form more easily along stray grain boundaries. Kurz and Gaumann studied the stray grain formation tendencies in terms of the degree of constitutional supercooling ahead of the growing dendrites during weld solidification. Using the same ideas, the present work investigated the stray grain formation tendencies and cracking behavior in welds of Rene N5, a nickel-base single-crystal superalloy. The thermal behavior during welding was modeled and the extent of constitutional supercooling ahead of the growing interface was quantitatively evaluated. In addition, the dendrite orientation with respect to the moving solid-liquid interface was also taken into account. The results supported the mechanism proposed by Kurz for stray grain formation. The analysis provides insight into the conditions needed in order to minimize stray grain formation during welding of nickel superalloys.

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