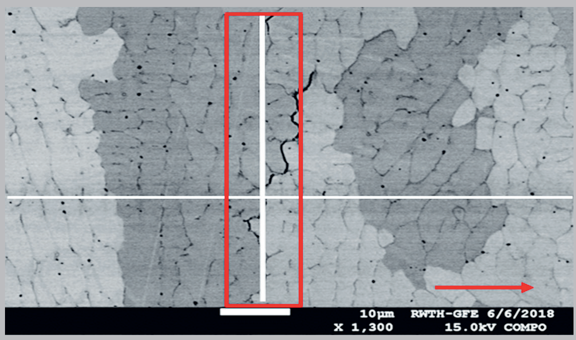

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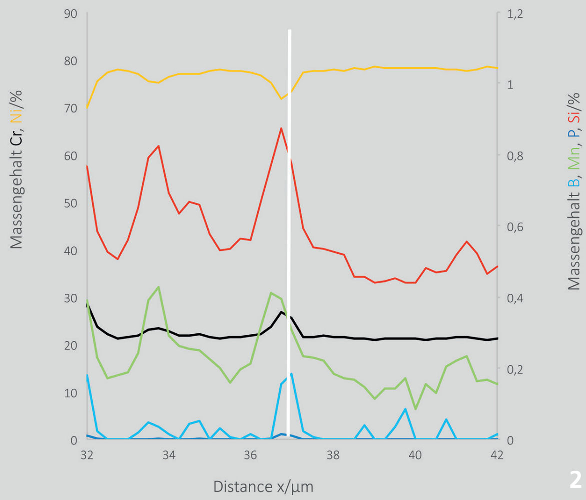

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CRACK FORMATION ANALYSIS IN WELDS OF NIMONIC 75 AND STELLITE 31

Task

In the course of developing a process, Fraunhofer ILT determined that Nimonic 75 and Stellite 31 could be suitably joined by welding. After the welding process was qualified, a modification of Nimonic was used, which resulted in hot crack formation. The cause of both the crack formation and the effective path had to be determined in an error analysis. Furthermore, a regulation had to be developed in order to prevent the error from occurring in the future.

Method

Welding tests have shown that the presence of boron, which is added to Nimonic 2.4951 to improve creep resistance, results in cracks during welding. With this alloy, the cracks were distributed over the entire weld seam, whereas with the 2.4630 modification they were limited to the slopes. To test the damage hypothesis, an electron microscopic study was carried out.

1 Microstructure in flat cut.

2 Element distribution (in the marked area).

Results

After the metallographic analysis did not reveal any differences between the material variants, the high-resolution electron beam microanalysis indicated that the welding defects were caused by boron. In the dendritically solidifying microstructure of the weld seam, this element results in precipitates forming at the grain boundaries through co-segregation with accompanying and alloying elements, in particular silicon; these precipitate remain as hot cracks in the microstructure due to their low ductility. From the results, the limits of the alloy constitution were derived with respect to crack-forming elements and an adjustment of the joining strategy. These findings are being incorporated into a repair process for turbine parts. In addition, the results show that generatively produced components can be welded safely since the alloys can be more easily adjusted than is the case with wrought alloys.

Applications

The alloys examined here are used in gas turbine construction due to their good properties at high temperatures. With the improved weldability and safety resulting from the research results presented here, welded joints of the two materials can also be used in apparatus engineering.

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