Weldability of Hastelloy B3*

G. A. Knorovsky, Sandia National Laboratories, Albuquerque, NM

Introduction/Background

Hastelloy B2 is a well-known Ni-based alloy normally considered as a corrosion-resistant material. However, for many years it has also had a good reputation as a pulsed laser weldable material, particularly when used in combination with Ni-based superalloys such as Alloy 718. Hastelloy B3 has recently superseded B2, and while similar, it has a significantly different chemistry, including increased amounts of Cr and W. We wished to determine if its weldability (particular in dissimilar combination) was as good as its predecessor alloy.

Procedure

We tested the autogenous weldability of B3 by preparing Gleeble and Varestraint specimens. Furthermore, dissimilar combination laser welds (with Alloy 718) were also prepared. These latter involved edge and circular patch-like geometries. Optical and scanning electron metallography (with energy-dispersive chemical analysis and backscattered electron Kikuchi pattern crystal structure analysis) were used to examine weld fusion zones for the presence and type of secondary constituents formed as a function of weld dilution. Calculations using thermodynamic phase diagram software were also made to determine expected stable and meta-phases.

Results and Discussion

Alloy B3 resulted from changes made to Alloy B2's chemistry with the intent of enhancing its thermal stability with respect to the solid-state formation of Ni-Mo intermetallic compounds. These are known to severely embrittle Alloy B2 during moderately-elevated temperature service. The changes included raising the allowable W and Cr contents. In other Ni-base alloys (such as C-276), W is known to promote the formation of eutectic-like constituents which solidify at temperatures well below the base alloy solidus, sometimes contributing to reduced weldability. In austenitic alloys, increasing Cr content is destabilizing relative to BCC, which in turn can promote sigma phase formation, though normally at much higher levels. In any case, when welded to Alloy 718 or other Ni-base superalloy, the Cr contribution from the B3 itself is minimal, so the effect of the increased W content, its segregation behavior, and the resulting change in secondary microstructural constituent content is of primary interest.

Autogenous weldability of Alloy B3 continues to be excellent as determined by Varestraint (in agreement with unpublished work by M.D. Rowe) and Gleeble ductility recovery temperatures. Some slight detail changes will be discussed relative to B2 in the light of the microstructural evidence obtained. Relative to the dissimilar weldability, only when the dilution with Alloy 718 (for example) causes significant compositional variation from the base alloy and hence significant changes in stability with respect to potential topologically close-packed or carbonitride phases is there any difference in behavior, which will also be discussed in light of the microstructural behavior found in this study.

Conclusion

We examine the autogenous and dissimilar weldability behavior of Hastelloy Alloy B3 and contrast the differences found relative to Alloy B2 in terms of the observed and thermodynamically-predicted phase stability behavior. In general, the weldability is found to be excellent, though for certain weld geometries in dissimilar welds with Ni-base superalloys such as Alloy 718, some care may need to be taken to avoid dilution effects which can reduce the normally good weldability.

***Sandia is a multiprogram laboratory operated by Sandia Corporation, a Lockheed Martin Company, for the United States Department of Energy under contract DE-AC04-94AL85000.