

SPB10. Development Of A 1080 To 316 Functionally Graded Joint

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Introduction

The power generation industry has long been aware of the problems that arise when a plain carbon steel and a stainless steel are welded together in boiler tube dutchmen. Premature tube failures arise from the fact that a boiler tube weld joins two materials with very different properties at a distinct interface, giving rise to a sharp transition in properties at that interface. Laser Engineered Net Shaping™ may be the solution to this problem by functionally grading the interface over a broader region and thus smoothing out the transition in properties from plain carbon to stainless steel.

Technical Approach & Results

The LENS™ build is a 3 inch long continuous tube that was fabricated by first depositing a half inch of 316 stainless steel onto a 1020 plain carbon substrate. This was then followed by two inches of functionally graded material, and concluded with a half inch of 1080 steel. The sample was then sectioned, ground, and polished using standard metallographic techniques. Then the sample was etched using several different etchants, each of which was used to expose the microstructure at different locations along the build. Wet chemistry was performed at thirteen locations along the sample to determine how the composition varied as a function of distance from the substrate. Hardness measurements were taken and microstructural characterization was performed along the length of the sample. The correlation between the wet chemical analysis, hardness data and microstructure was then demonstrated by choosing representative micrographs detailing key features of the structure.

Conclusions

The results of both the hardness measurements and the microstructural characterization show that the transition in mechanical properties from 316 to 1080 was relatively smooth as expected. At the interface between the functional grade and the pure 1080 there was a hardness peak due to the formation of martensite. This does not, however, mean that LENS™ is not the answer to the boiler tube issue. Several processing parameters need to be explored to potentially eliminate this peak. Overall, the functional grade exhibits a very gradual change in both structure and hardness, which is promising for future work.