



Metallurgical Assessment of Weldment Quality for a Single Peg Hook

Welding is a process for joining two metal parts together and it plays a significant role in the modern metal manufacturing industry. In this application note, the quality of a weld in a single peg hook is assessed microstructurally and mechanically. Figure 1 shows top down and side view optical images of this welded carbon steel peg hook. The weld can be clearly seen between the two bent metal rods in the side view image.



Figure 1. Images of the welded peg hook looking from the top (left) and the side (right).

To evaluate the quality of the weld, a visual inspection of the weld was performed first. The weld appeared smooth and without obvious defects. To further examine the interface, the hook was cut at the weld and mounted in an epoxy metallurgical mount. The cross section was ground and polished using sandpaper followed by a $0.3\ \mu\text{m}$ Al_2O_3 suspension on a polishing cloth to create a smooth surface. MicroVickers hardness measurements were taken at several points across the weld area. After microhardness testing, the cross-sectioned specimen was etched with Nital (5%) for about 10 seconds to reveal the microstructure of the weld.

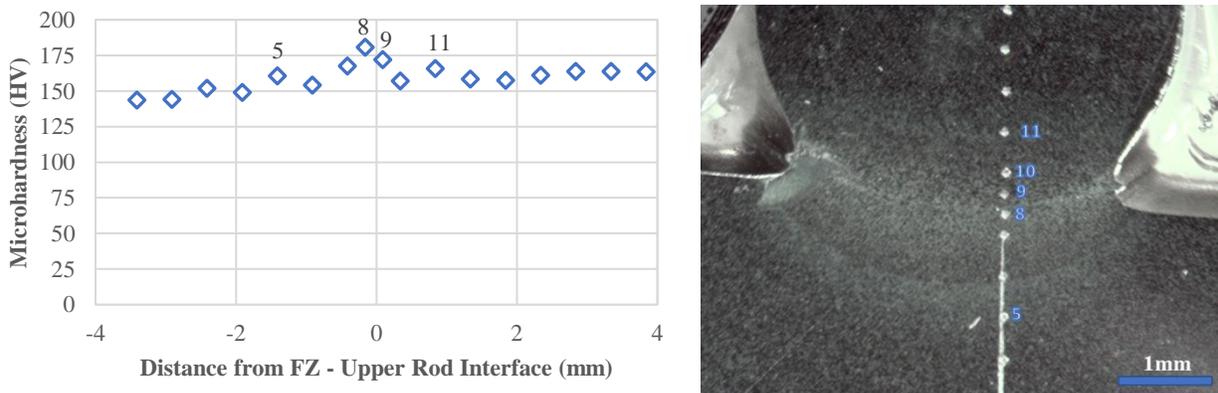


Figure 2. Microhardness profile across the weld (left). Optical image of the weld after Nital etching with microhardness indents numbered from bottom to top (right).

Figure 2 shows the microhardness distribution and optical image of the weld cross-section. As illustrated in the optical image, indents 1-5 are in the lower rod, 6-8 are in the fusion zone, and



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indents 9-17 are in the upper rod. It is clear that the hardness values measured across the two rods and the fusion zone (FZ) are similar in scale, which indicates the weldment has the desired uniformity of mechanical properties.

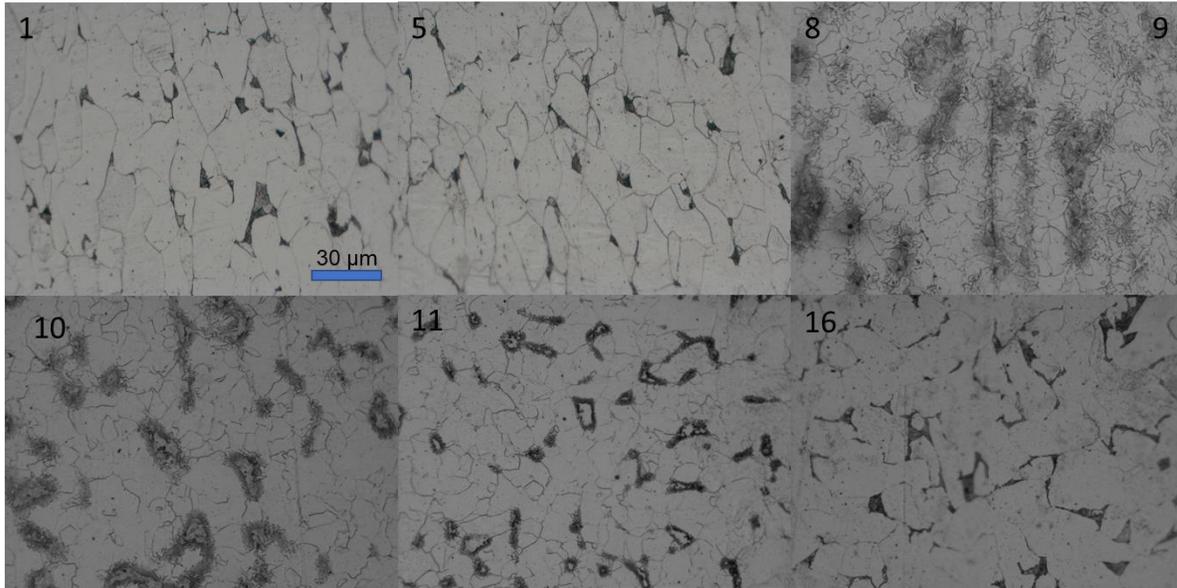


Figure 3. Microstructures of the weld at different locations; the numbers correspond to the locations of the indentation sites shown in Figure 2.

Figure 3 displays the micrographs of the weld in different areas. The labels shown on the images correspond to the indent numbers marked on Figure 2. Since Nital has preferential etching capabilities, the lighter areas in the micrographs represent nearly unetched ferrite and the darker areas represent the etched carbides, grain boundaries, pearlites, or cementites.

Micrograph #1 and #16 present the microstructures of the base metal outside the weld. As expected from a low-carbon steel, a small percentage of pearlite was observed at the ferrite grain boundaries. A vertically elongated texture was also observed in the ferrite matrix as shown in Micrographs #1 and #5. The texture was likely formed during the rod fabrication process. The lack of elongated texture in Micrograph #16 was probably due to the cross-section direction. Micrograph #8 depicts the microstructure of the fusion zone. It can be seen from Micrograph #8 that the microstructure exhibits equiaxial grain structure, smaller grain size than the base metal, and significant carbon dispersion. These characteristics are likely a result of the rapid melting and cooling during the welding process. Micrograph #10 shows the microstructure of the heat affected zone. The microstructure indicates that the high temperatures in the heat affected zone caused carbon to partially diffuse out from pearlite and cementite. Micrograph #11 exhibits the same microstructural characteristics as Micrograph #10, but to a lesser degree as it was further from the fusion zone.

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