Pitting of Laser-Welded HSLA Steels

Y.M. Looi [1], J.H.W. de Wit [1, 2], H.S. Isaacs [3]

[1] Netherlands Institute for Metals Research (NIMR), 2600 GA Delft, The Netherlands.
[2] Delft University of Technology, Rotterdamseweg 137, 2628 AL Delft, The Netherlands.
[3] Brookhaven National Laboratory, Upton, New York 11973, United States of America.

Laser welding is now widely used in metal working industries to produce welds in, for example, automobiles, pacemakers and cigarette lighters [1-3]. Compared with tungsten arc welding, laser welding produces narrower weld beads and heat-affected-zones (HAZ), which are commonly identified as corrosion susceptible areas.

This study was carried out to determine the susceptibility of the weld bead and heat affected zone produced by the highly localized heat input during the laser welding process [4]. We investigate the pitting corrosion of steel sheets for automobile applications by performing electrochemical measurements and optical observation using a Difference Viewer (Applicable Electronics Inc.) image subtraction technique. This approach allows synergism between the two methods and enhances the in situ visualizing of surface changes which are extremely difficult to observed using common imaging methods.

All samples were abraded to 600 grit, and adhesive tape was applied on the surface leaving 6 x 6 mm exposed to reduce crevice corrosion [5]. The sample was then vertically mounted and exposed to air saturated 0.5M NaCl. The sample was held at -800mV to reduce the surface oxide during optical set-up, and then exposed at –500mV (vs. SCE) for an hour [6,7].

The first set of pits was randomly distributed on the surface. Pits were visually observed about 100 seconds at -500mV whereas the pits could be detected using the Difference Viewer after 40 seconds of immersion. Figure 1 is the real time optical image taken after 40 s. The insets (a) show magnified optical images and insets (b) are the same location obtained by subtracting and amplifying the difference from earlier image. With time only pits present at the weld were seen to grow (Figure 2) and then propagate occurred along the weld. Areas of corrosion spread over the entire surface from these pits but also from what was apparently crevice corrosion along the adhesive tape. After 1 h exposure the sample was removed, washed and dried, and optical microscopy (Figure 3) showed selective micro-pitting along the fusion line and at the center of the weld.

These results demonstrate that the fusion lines and the center of the weld are preferentially attacked. These results differ from those observed using conventional techniques where the HAZ is the most susceptible region [4,8,9].

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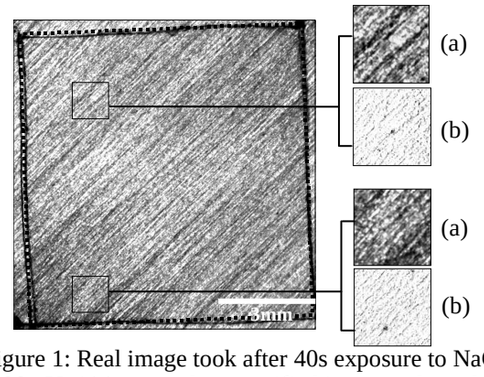

Figure 1: Real image took after 40s exposure to NaCl at -500mV. 1(a)s were the magnified images where the pit observed and (b)s were the difference subtracted images at the same magnification which clear shown the location of pits.

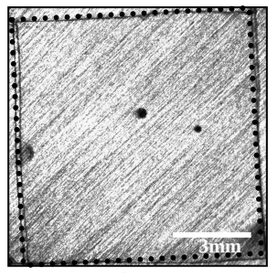

Figure 2: Picture after 16 minutes of the exposure time. Pits at the weld and fusion line continue to grow.

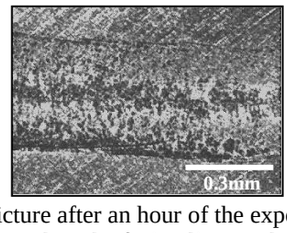

Figure 3: Picture after an hour of the exposure time. Pits selectively attack at the fusion lines and at the centre of the weld.