

NATIONAL TRANSPORTATION SAFETY BOARD

Office of Research and Engineering
Materials Laboratory Division
Washington, D.C. 20594



June 20, 2018

MATERIALS LABORATORY FACTUAL REPORT

Report No. 18-037

1. ACCIDENT INFORMATION

Place : Chetek, Wisconsin
Date : May 24, 2017
Vehicle : Piper J3C-65, N35132
NTSB No. : CEN17FA196
Investigator : Jennifer Rodi, AS-CEN

2. COMPONENTS EXAMINED

Rear seat lapbelt wire/bracket assembly
Rear seat lapbelt wire/bracket assembly (intact)

3. DETAILS OF THE EXAMINATION

On May 24, 2017, about 1830 central daylight time, a Piper J3C-65 airplane, crashed into a river 3.5 miles southwest of Chetek, Wisconsin. The private pilot was fatally injured, and the passenger was seriously injured. The airplane sustained substantial damage. According to several witnesses in the area, while flying over a pond, they stated that they heard a "pop" noise from the engine which they characterized as a backfire. One witness stated that the engine was at a lower rpm as the airplane flew over him. After the "pop" the airplane descended below the tree line and the witnesses heard the crash. The airplane wreckage was located in the Red Cedar River. The wreckage included both wings, the empennage, fuselage, and the engine and propeller assembly.

The rear seat lapbelt wire brackets are shown in Figure 1 and Figure 2, as received. The left bracket had fractured in two places, labeled the "flat side" and "bent side" fractures for the purpose of this report. These labels were consistent with the sides of the bracket where they were located. In Figure 1, the flat side fracture was the lower fracture, and the bent side fracture was the upper fracture. The mating fractures were not received.

Figure 2 shows the right side rear seat lapbelt wire bracket, used as an exemplar in this investigation. This bracket was cut prior to receipt, as seen in the upper portion of Figure 2. This bracket also had a metallic cylindrical sheath affixed. This bracket and the fractured bracket were essentially sections of wire bent into shape, and then butt welded on one side.

Figure 3 shows the markings on the fractured bracket stating, "RegOroD No. 11". The right side bracket did not exhibit any visible markings or identification marks.

Figure 4 shows the bent side (upper) fracture surface, viewed from end on and from the side. This fracture surface was located 0.05 inches from the bend on the bracket rod (see Figure 4b). The fracture surface exhibited two distinct regions visually. Approximately one third of this fracture surface appeared darker and flatter. This region exhibited features consistent with having been smeared and rubbed. Near this portion of the fracture surface, a portion of the wire, seen facing down in Figure 4b, appeared flattened and smoothed, consistent with rubbing or contact with another object.

The other two thirds of the bent side fracture surface appeared shinier in luster and rougher in texture. The area of the wire adjacent to the fracture surface exhibited plastic deformation. These features were consistent with fracture from overstress.

Figure 5 shows the flat side fracture surface, viewed end on and from the side. The fracture surface exhibited shear lips around the edges of the fracture surface, exhibiting a general cup shape. The portions of the wire adjacent the fracture surface exhibited plastic deformation such as necking. A portion of the wire adjacent to the fracture surface (facing upward in Figure 5b) was flatter and smoother than the rest of the wire. This flatter section was located on part of the fracture surface.

The fracture surfaces were examined using a scanning electron microscope (SEM). Figure 6 shows the face of the bent side fracture surface. As viewed in the visual examination, much of the fracture surface exhibited dimple rupture, generally oriented in a slanted direction (Figure 7). This feature was consistent with fracture from overstress in shear. The other third of the bent side fracture surface exhibited features consistent with rubbing and smearing, as typified in Figure 8.

Figure 9 shows the fracture surface of the flat side of the bracket. As shown in Figure 10, this fracture surface exhibited dimple rupture, consistent with overstress fracture. Half of the fracture surface dimple features were oriented normal to the fracture surface (Figure 10b) and the other were oriented at an angle (Figure 10a).

The bracket wire was sectioned near the bent side fracture surface, and was then mounted, polished, and etched in cross section. The chemical composition of the bracket was examined using energy dispersive x-ray spectroscopy (EDS) on the polished cross section. The composition was consistent with a plain carbon steel. EDS examination of the exterior of the bracket near the fracture surface found elevated levels of aluminum, along with detectable levels of calcium, chlorine, sodium, and potassium.

Figure 11 shows a typical area of the bracket microstructure. The microstructure, oriented with the rolling/longitudinal direction running left and right in the figure, was consistent throughout. The microstructure consisted of equiaxed grains, with multiple inclusions present. These inclusions were consistent with manganese sulfide phases typical of this steel alloy.

A typical area of the surface of the wire bracket cross section is illustrated in Figure 12. The surface often exhibited pits that contained corrosion products (dark features in Figure 12). Examination of these corrosion products using EDS found them to be consistent with iron oxide.

The hardness of the shaft was inspected per ASTM E384.¹ The hardness averaged 71 HRB (127 HV₅₀₀). This hardness was typical of steel alloys the chemical composition and microstructure observed.

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¹ ASTM E384 – *Standard Test Method for Knoop and Vickers Hardness of Materials*. ASTM International, West Conshohocken, PA



Figure 1 – The fractured wire bracket, viewed from (a) the observe and (b) the reverse side. The bracket had fractured in two places, labeled “flat side” fracture (lower) and “bent side” fracture (upper).



Figure 2 – The exemplar right side wire bracket as received viewed from (a) the obverse and (b) the reverse side. The upper bent portion had been cut prior to receipt.



Figure 3 – View of the markings on the side of the fractured wire bracket.



Figure 4 – The bent side fracture (upper fracture in Figure 1) viewed (a) end on, showing two visually distinct regions and (b) from the side.



Figure 5 – The flat side fracture (lower fracture in Figure 1) viewed (a) end on, showing two visually distinct regions and (b) from the side.

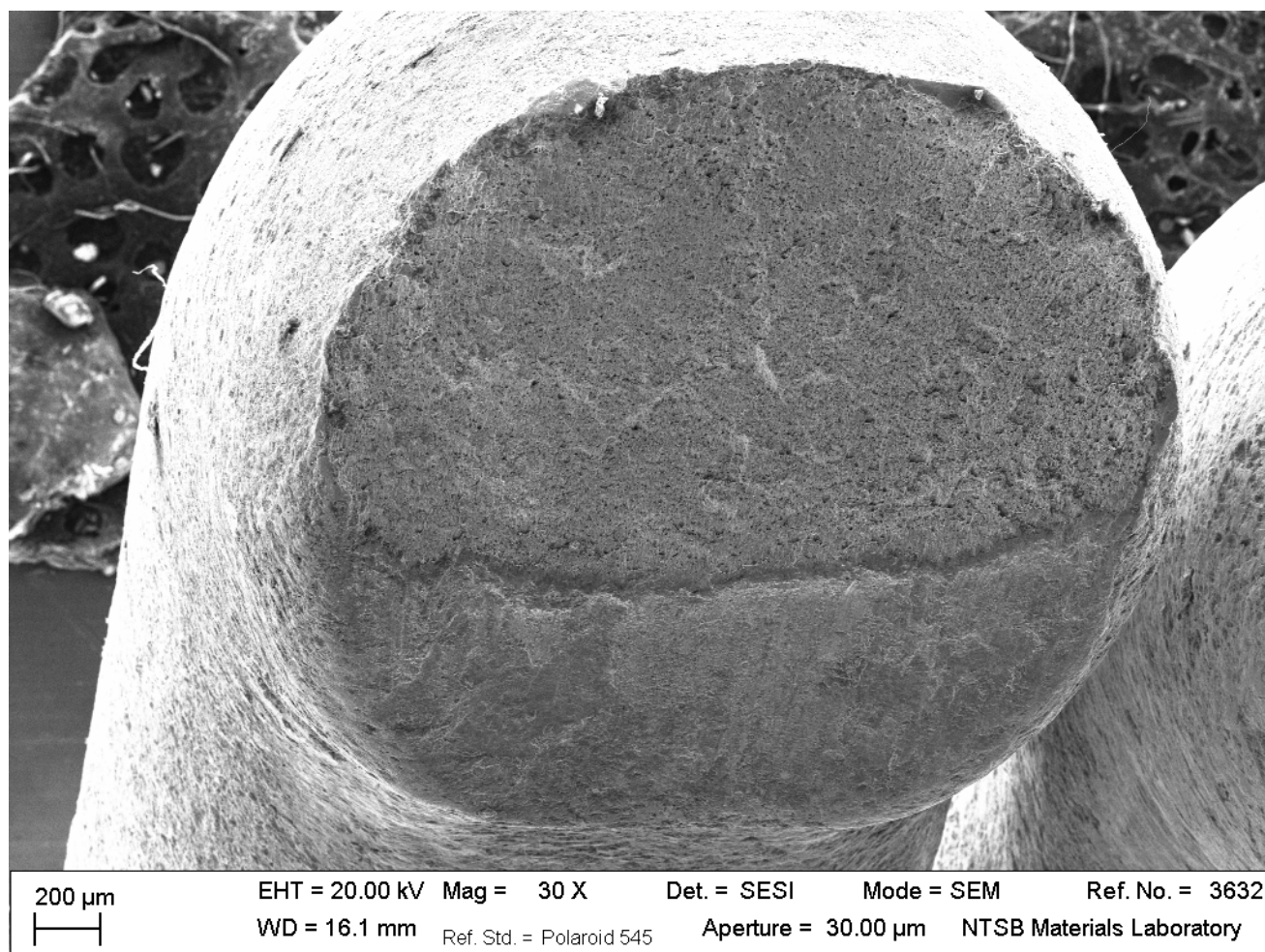


Figure 6 – Secondary electron (SE) micrograph showing the bent side fracture surface.

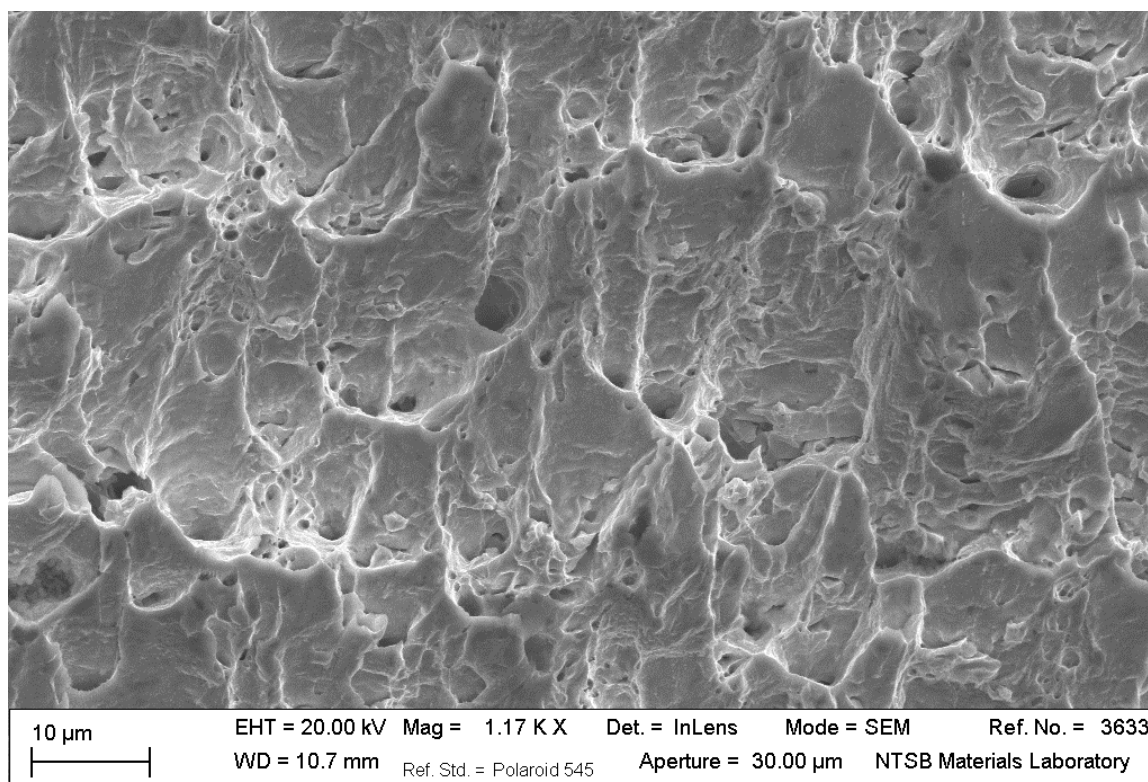


Figure 7 – SE micrograph showing a typical portion in the upper region of the Figure 6 fracture surface, showing dimple rupture.

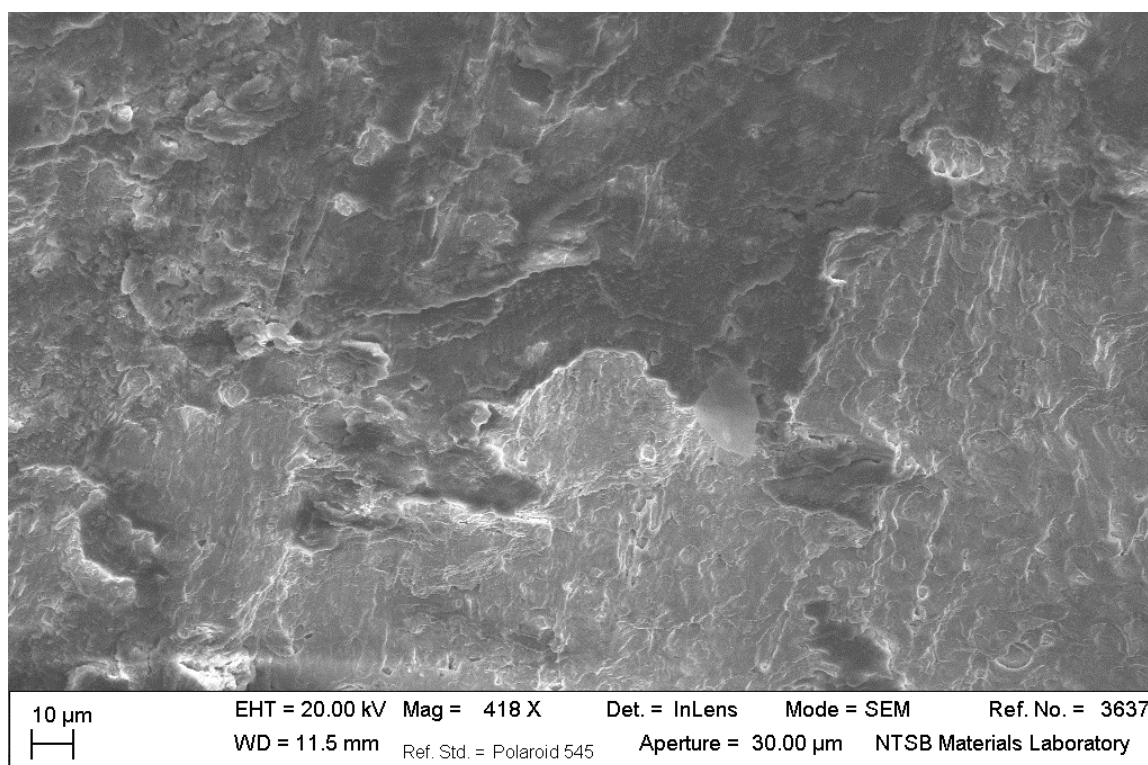


Figure 8 – SE micrograph of the lower region of the Figure 6 fracture surface, showing smearing and rub marks.

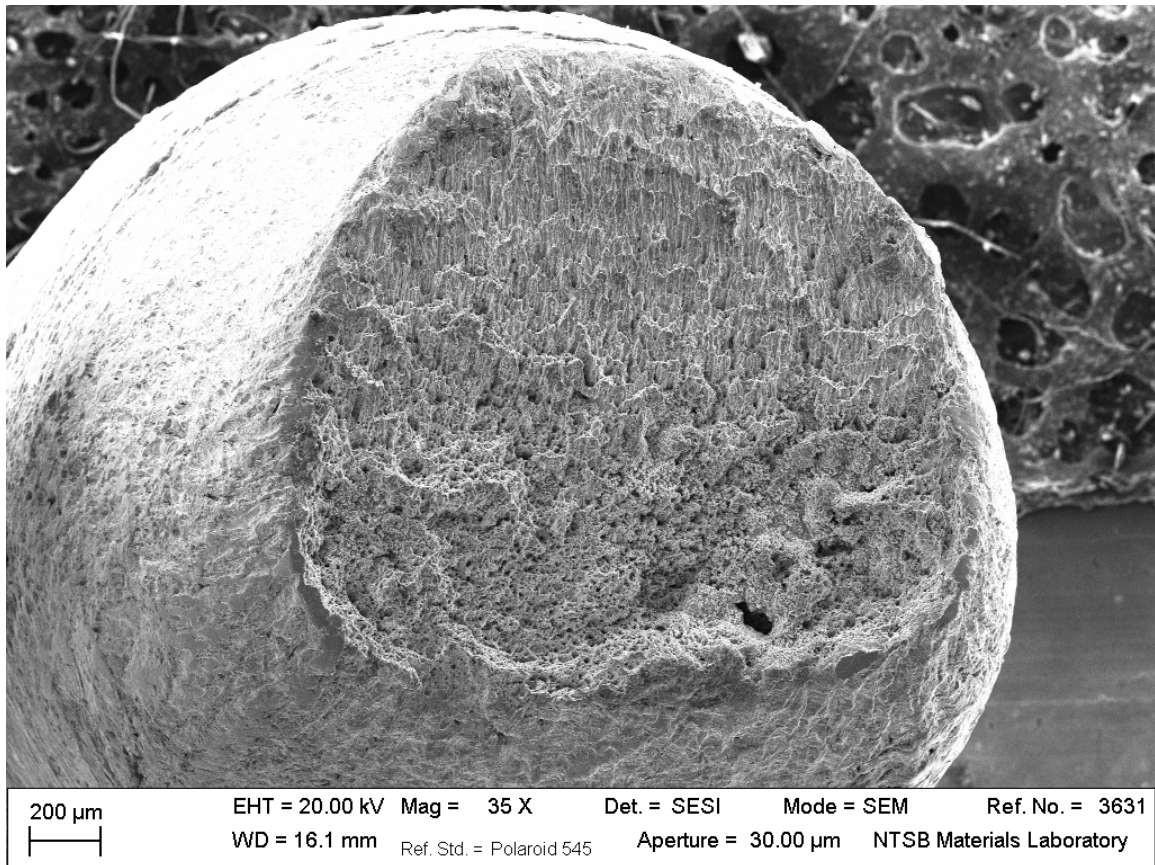


Figure 9 – SE micrograph showing the flat side fracture surface.

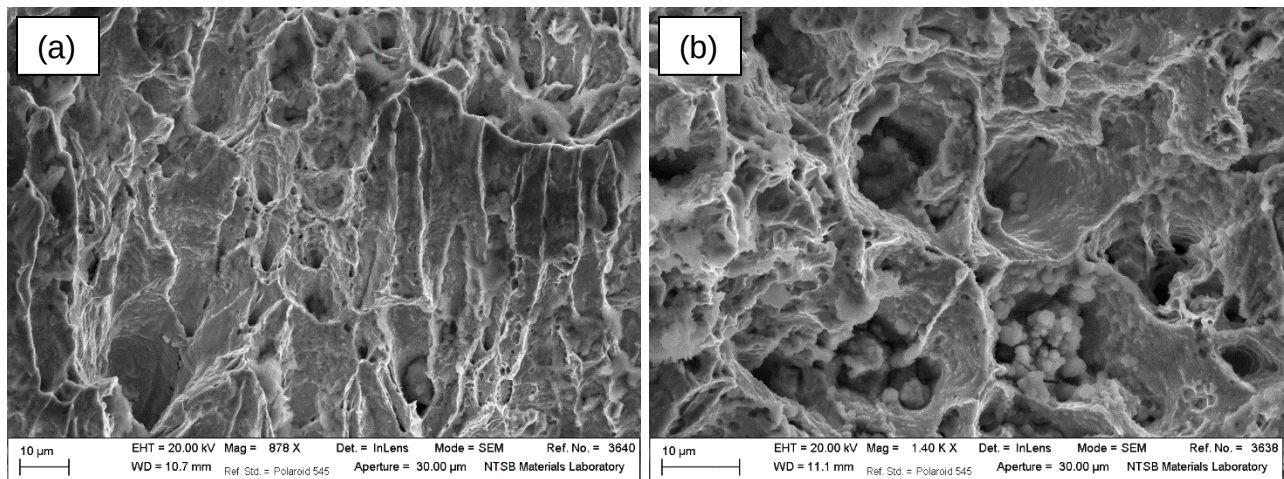


Figure 10 – SE micrographs of the bent side fracture features showing (a) slanted dimple rupture in the upper portion Figure 9 and (b) normal oriented dimple rupture in the lower portion of Figure 9.

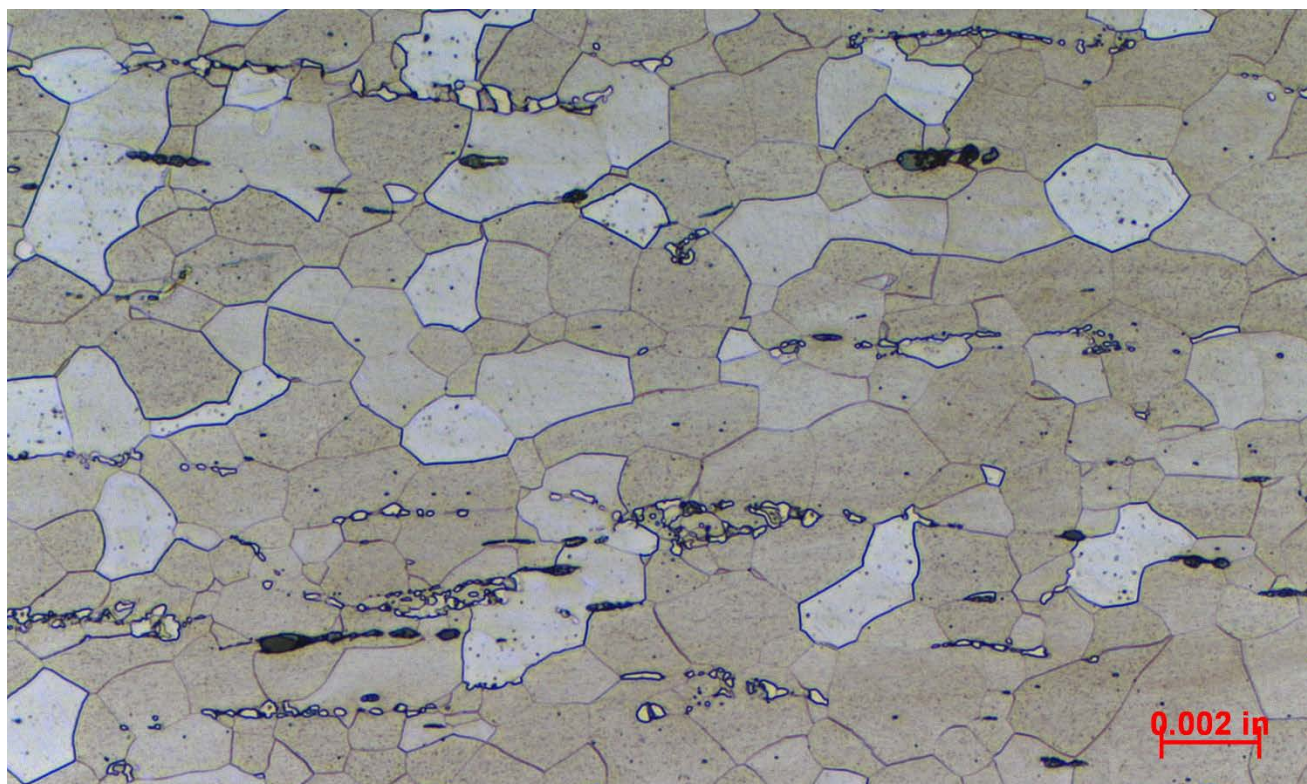


Figure 11 – Bright field (BF) optical micrograph of a typical portion of the bracket microstructure, oriented in the longitudinal direction (~500X, etched 2% Nital).

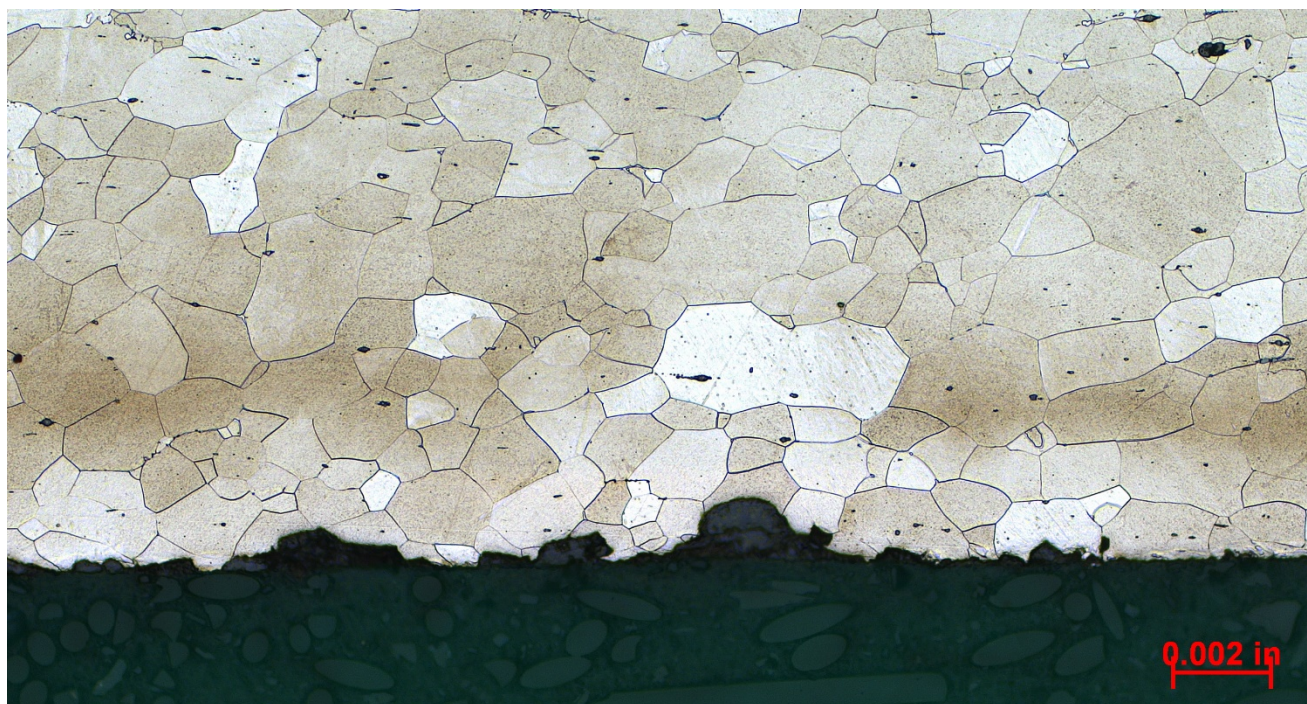


Figure 12 – BF optical micrograph of the surface of the wire bracket showing corrosion pitting on the surface.