

NATIONAL TRANSPORTATION SAFETY BOARD

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



December 28, 2012

MATERIALS LABORATORY FACTUAL REPORT

Report No. 12-148

A. ACCIDENT INFORMATION

Place : Homer, Alaska
Date : July 29, 2012
Vehicle : Bellanca 8KCAB Decathalon
NTSB No. : ANC12IA085
Investigator : Chris Shaver, AS-ANC

B. COMPONENTS EXAMINED

Left main landing gear leg.

C. DETAILS OF THE EXAMINATION

An overall view of the submitted left main landing gear leg is shown in figure 1. The leg is displayed as viewed looking at the lower surface. The leg was fractured near the middle of the bend between the horizontal and angled portions of the leg near the inboard end as shown in figure 1.

An overall view of the fracture surface on the inboard side of the fracture is shown in figure 2. Portions of the fracture surface had relatively smooth and flat fracture features with a curving boundary and no shear lip at the edge of the fracture,¹ features consistent with fatigue. Four separate areas of fatigue were observed emanating from the lower surface, and these areas are indicated in figure 2 with brackets. The largest area of fatigue, located near the middle of the width of the leg, was 0.65 inch wide along the lower surface and extended upward to a maximum depth of 0.12 inch. The remainder of the fracture surface had a matte gray appearance with radial features indicating final fast fracture propagation emanating from the two largest fatigue regions as indicated with arrows in figure 2. Some of the fracture was covered with orange oxide, consistent with post-fracture oxidation of the surface.

A closer view of the largest fatigue region is shown in figure 3. The fatigue features emanated from multiple origin sites. Arrows in figure 3 indicate origins located at the lower surface along the fatigue region. The origins were separated by ratchet marks of varying size.² A dashed line in figure 3 indicates the extent of fatigue propagation.

¹ A shear lip is a change of fracture plane that occurs near a free surface during ductile overstress fracture.

² A ratchet mark is a small step in the fracture surface formed when two adjacent fatigue cracks originate on slightly offset planes.

The forward portion of the largest fatigue region is shown at higher magnification in figure 4. The fatigue generally originated from pits in the lower surface. Arrows in figure 4 point to the pits observed at fatigue origins. The pits were filled with brown paint, and the brown paint was covered with white paint.

Multiple cracks were observed in the paint near on the lower surface near the fracture surface. The surface was partially covered with dirt and debris, so the surface was cleaned using soapy water and a soft-bristle brush. Paint cracks on the lower surface are shown in figure 5 after cleaning. The cracks were mostly aligned in the transverse direction.

To facilitate further examination of the fracture surface and adjacent surfaces, the inboard piece of the landing gear leg was sectioned using an abrasive saw in a transverse plane approximately 1 inch away from the fracture surface (see lab cut location in figure 1). Next, paint was removed from the upper and lower surfaces of the sectioned piece containing the fracture surface using Cee-Bee A-202 paint stripper,³ a wood scraper, and a soft-bristle brush followed by rinsing with water and then alcohol.

A view of the lower surface adjacent to the fracture surface after paint removal is shown in figure 6. The lower surface had a roughened surface consistent with a shot blast treatment with a 250-microinch surface finish. Most of the surface had a flat uniform appearance, but discrete pits were observed scattered around the surface. Arrows in figure 6 point to a cluster of pits observed in one area near the fracture surface. Some of the pits remained covered in paint. The exposed pits appeared to have a shot blast finish similar to that of the remainder of the surface.

The sectioned piece of the landing gear leg was examined next using a scanning electron microscope (SEM). Oblique-angle SEM views of the fracture surface and adjacent lower surface at an origin area of the largest fatigue region are shown in figure 7. The box in the upper image of figure 7 highlights a pit feature on the lower surface at a fatigue origin, and the pit is shown at higher magnification in the lower image. Arrows in the lower image in figure 7 point to the edge of the pit. Deformed material appeared to lip over the edges of the pit at locations indicated by arrows.

Secondary cracks were observed on the lower surface near the fracture surface. One area with secondary cracks on the lower surface just inboard of the largest fatigue region is shown in figure 8. Arrows in figure 8 point to several of the observed secondary cracks.

A cross-section in a vertical plane perpendicular to the fracture plane was cut for a metallographic examination (see metallographic cross-section location noted in figure 1). The metallographic cross-section intersected a portion of the largest fatigue region. A secondary crack was observed in the cross-section emanating from the lower surface at a location near the fracture surface. Pits were observed in several locations along

³ McGean, Cleveland, Ohio

the lower surface. One of the deeper pits is shown in figure 9. An arrow in figure 9 indicates a lip of deformed material that is formed at the edge of the pit.

Matthew R. Fox
Senior Materials Engineer



Figure 1. Overall view of the fractured left main landing gear leg showing the lower surface of the leg.

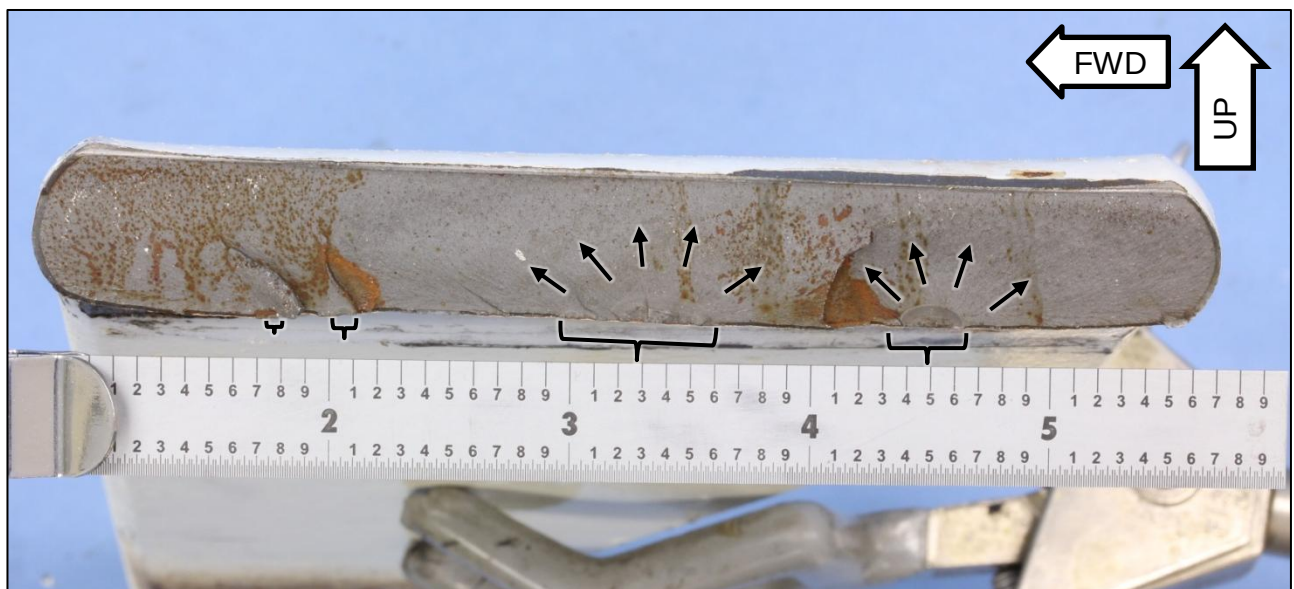


Figure 2. View of the inboard side of the fracture. Brackets indicate multiple fatigue regions originating at the lower surface, and arrows indicate fracture propagation directions emanating from the two largest fatigue regions.

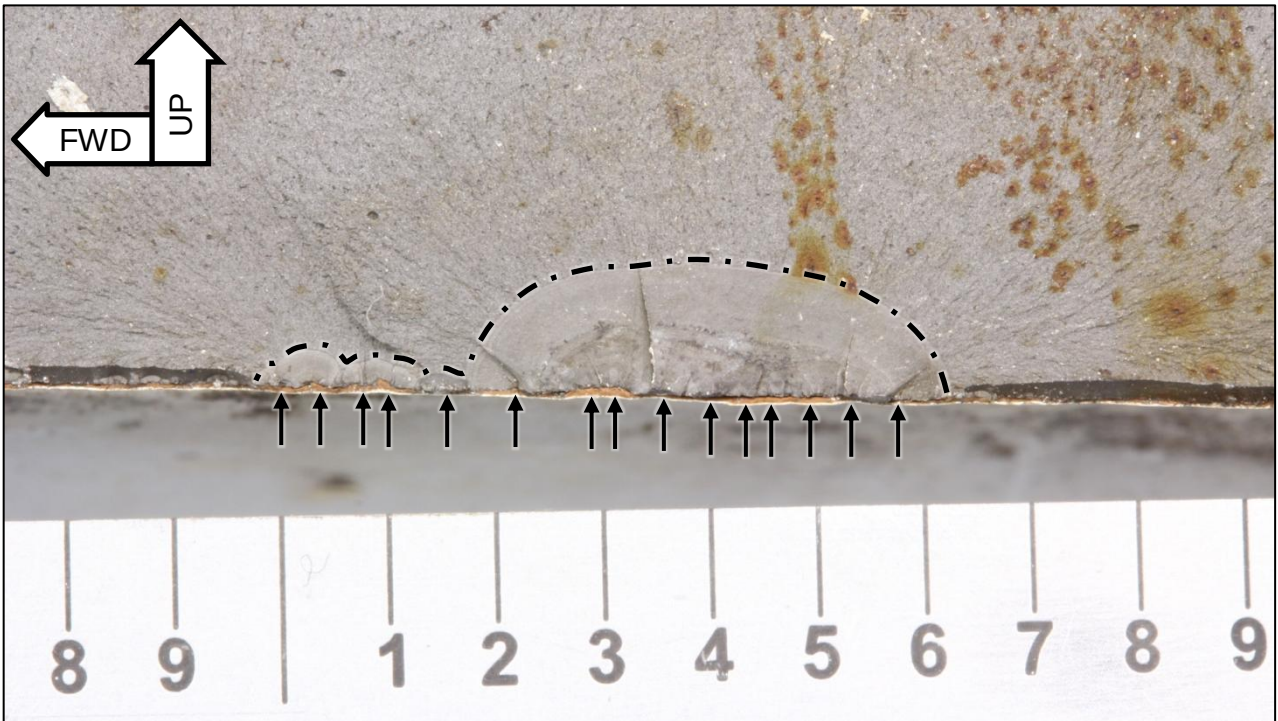


Figure 3. Close view of the largest fatigue region. Arrows indicate individual fatigue origin sites, and a dashed

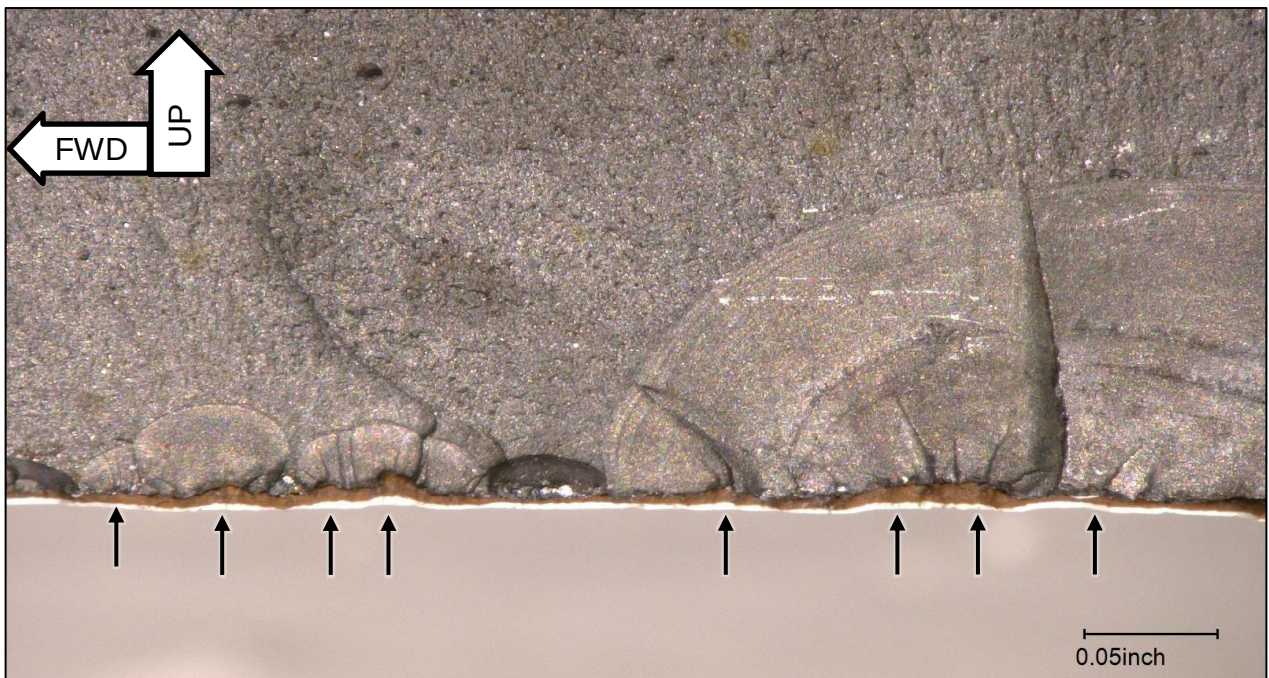


Figure 4. Close view of several of the fatigue origins. Arrows point to pits at the fatigue origins. The pits were filled with brown paint.

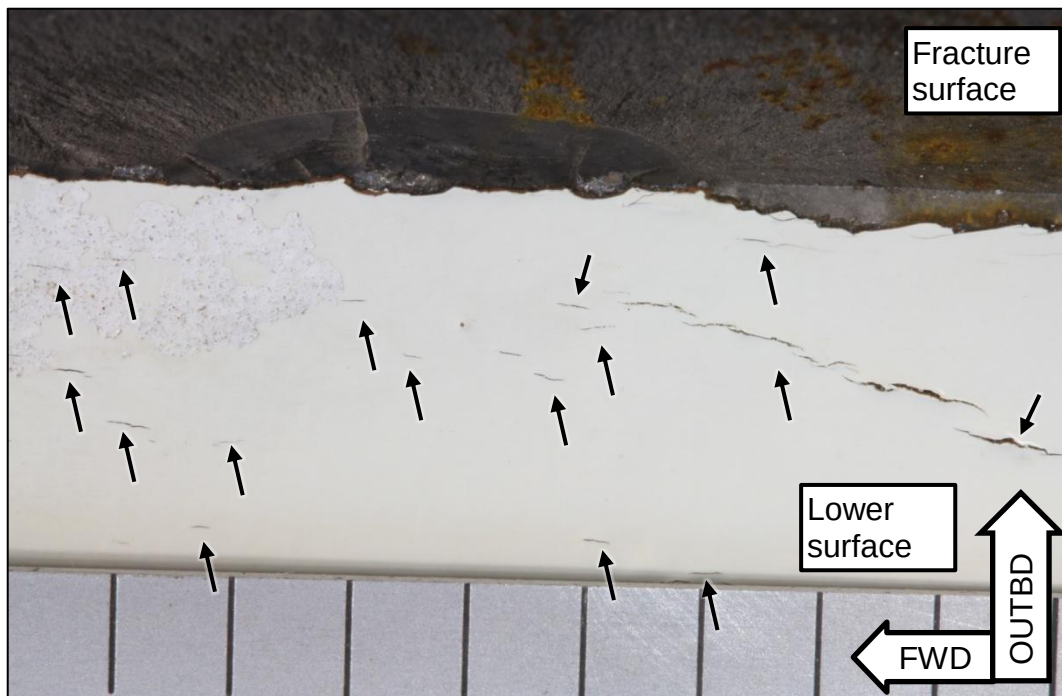


Figure 5. View of the lower surface adjacent to the fracture surface after cleaning with soapy water. Arrows indicate multiple cracks observed in the paint.

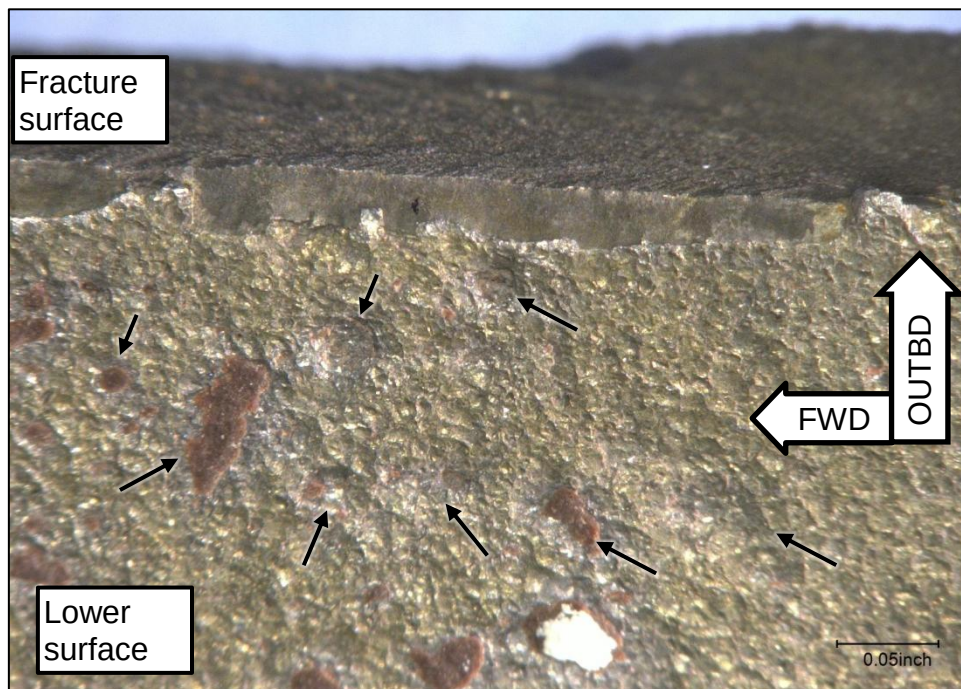


Figure 6. View of the lower surface adjacent to the fracture after paint was mostly stripped away. Arrows indicate pits in the surface. Paint filled some of the pits.

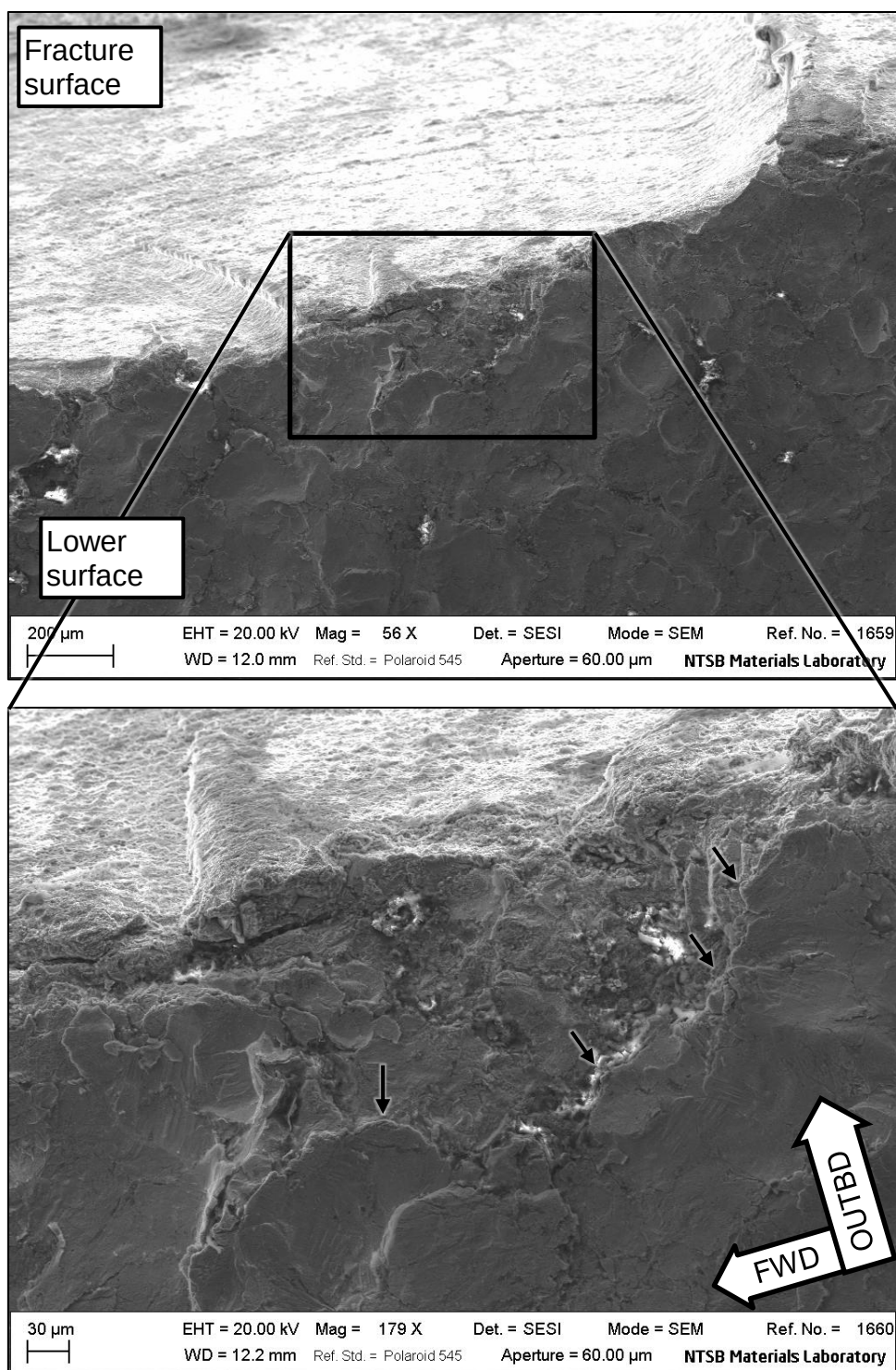


Figure 7. SEM views of a pit at the primary origin area of the largest fatigue region. Deformed material appeared flowed over the edges of the pit.

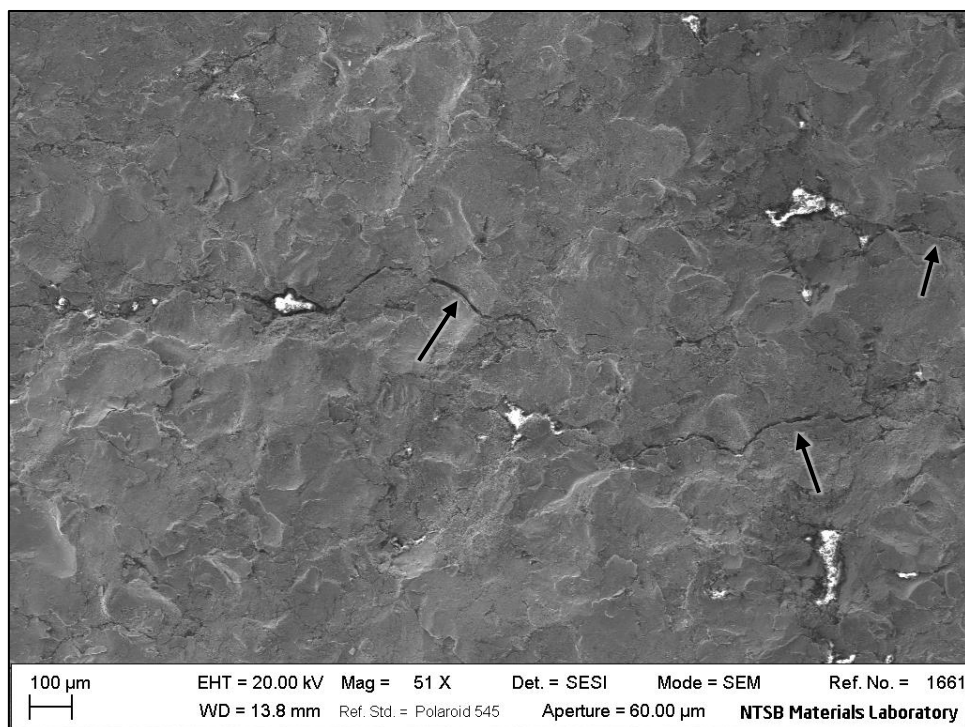


Figure 8. SEM view of the lower surface of the leg near the largest fatigue region. Arrows indicate secondary cracks on the surface.

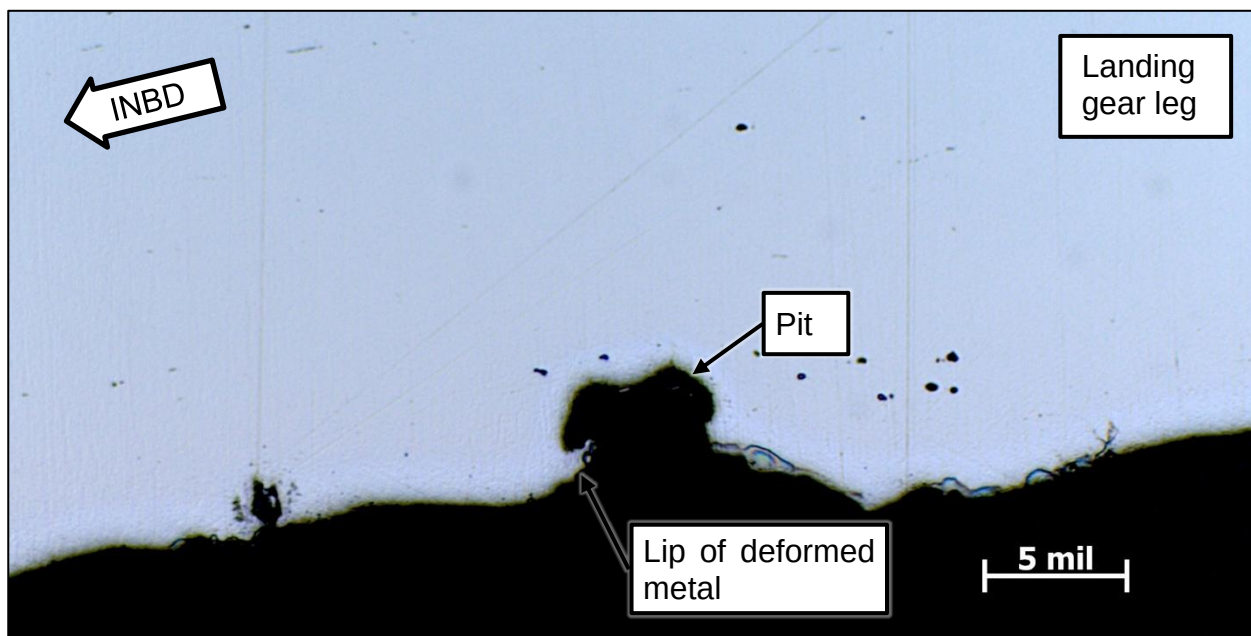


Figure 9. View of a pit on the lower surface of the main landing gear leg showing a lip of deformed metal at the edge of the pit.