

NATIONAL TRANSPORTATION SAFETY BOARD

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



October 12, 2021

MATERIALS LABORATORY FACTUAL REPORT

Report No. 21-075

1. ACCIDENT INFORMATION

Place : Jeffersonville, Indiana
Date : August 3, 2021
Vehicle : Piper PA-28-181, N728A
NTSB No. : CEN21LA353
Investigator : John Brannen, AS-CEN

2. COMPONENTS EXAMINED

Remnants of bolts from a right main landing gear

3. DETAILS OF THE EXAMINATION

On August 3, 2021, about 1115 eastern daylight time, a Piper PA-28-181 was substantially damaged when it was involved in an accident near Clark Regional Airport near Jeffersonville, IN. The flight instructor and student pilot were not injured. The flight instructor reported that the approach and landing were normal with the airplane touching down on the main landing gear with the engine at idle. The airplane was left of centerline and began drifting toward the right. The student and flight instructor both attempted to correct for the drift, but the airplane departed the right side of the runway. The right main landing gear struck a runway light and separated from the airplane. The airplane incurred substantial damage to the right wing and fuselage.

Several remnants of attachment bolts from the right main landing gear were received by the NTSB Materials Laboratory, as pictured in Figure 1. There were four fragments, labeled individually upon receipt, as demonstrated in Figure 1. Two pieces were labeled as being the top and bottom remnants of the outboard position. Another was labeled as being the top fragment, second from outboard, and the last one was labeled as being the bottom fragment from an inboard position.

Figure 2 shows a closer view of the bottom inboard fragment. This fragment included the bolt head and part of the shaft. Figure 3 shows the markings on the bolt head,

which stated, "X" and "01DO." These markings were consistent with having been manufactured by Mac Fasteners.¹

There was some bending and shear deformation near the bolt fragment fracture surface. This included an exuded portion of material on the lower left of Figure 2. This area is shown on the image of the bolt fracture surface on the lower right of Figure 4. On the opposite side of the fracture surface (upper left of Figure 4), the edges had been beveled and exhibited rounding and streaks, consistent with shearing damage towards the lower right in the figure.

The fracture surface itself was relatively flat. Most of the fracture surface exhibited a reflective luster with randomly oriented streaks, consistent with post-fracture smearing damage. The lower left portion of the fracture surface was less damaged, and exhibited a dull, fibrous luster with rougher surface texture. The fracture surface was examined using a scanning electron microscope (SEM). Figure 5 shows a typical area of the undamaged portion of the inboard bottom bolt fracture surface. As illustrated in Figure 6, the fracture surface exhibited elongated dimpled rupture, consistent with fracture from overstress in shear.

Figures 7 and 8 show the outboard bolt remnants from the bottom and top, respectively, as viewed from the side. The nut was still attached to the threaded portion of the shaft on the top remnant. The head on the bottom remnant exhibited the same markings as the inboard bolt remnant shown in Figure 3, "X" and "01DO." The bolt exhibited deformation near the fracture surfaces in the form of thinning, bending, and material displacement perpendicular to the shaft direction. In addition, the areas of the shaft closest to the head and the threaded region with the nut exhibited circumferential wear and gouging marks.

Figures 9a and 9b show the fracture surfaces from the bottom and top remnants, respectively. Both fracture surfaces exhibited a general dull, fibrous luster with a rough surface texture. With both faces, approximately half of the fracture surface was oriented perpendicular to the bolt shaft direction, and the other half was at an angled orientation. This angled protrusion on the top face had been heavily damaged by post-fracture smearing and gouging.

The fracture surface was examined using a SEM, showing a typical undamaged area in Figure 10. As shown in Figure 11, this area exhibited dimpled rupture, consistent with overstress fracture. These combined features were consistent with overstress fracture of the bolt in bending and shear.

Figure 12 shows the top remnant of the fastener labeled second from outboard. The bolt had fractured along the shaft approximately 1.25 inches from the threaded region and was bent at an approximately 45° angle 1 inch from the threaded region. The bent portion

¹ Mac Fasteners is a bolt manufacturing company located in Ottawa, KS. The manufacturer is now a subsidiary of TriMas Aerospace, headquartered in Irvine, CA.

exhibited circumferential wear marks, consistent with rotation, and longitudinal wear marks, consistent with fretting or sliding.

Figure 12 also shows thinning of the shaft in the form of necking next to the fracture surface. Viewing the fracture surface in Figure 13, the surface exhibited a general cup or concave shape. The edges, consistent with shear lips, had been deformed and damaged, as exhibited by the reflective streaked areas along the periphery—these features were consistent with post fracture damage.

A portion of the undamaged area of the bolt fracture surface is illustrated in Figure 14. As shown in a closer view in Figure 15, these features were consistent with dimpled rupture. The combined features of this bolt remnant were consistent with having fractured from overstress in tension and bending. None of the bolt fracture surfaces exhibited features consistent with pre-existing damage, such as cracks, corrosion, or large inclusions.

The chemical compositions of the bolts screws were examined using energy dispersive x-ray spectroscopy (EDS). The compositions were consistent with an alloy steel.

Erik M Mueller
Materials Research Engineer

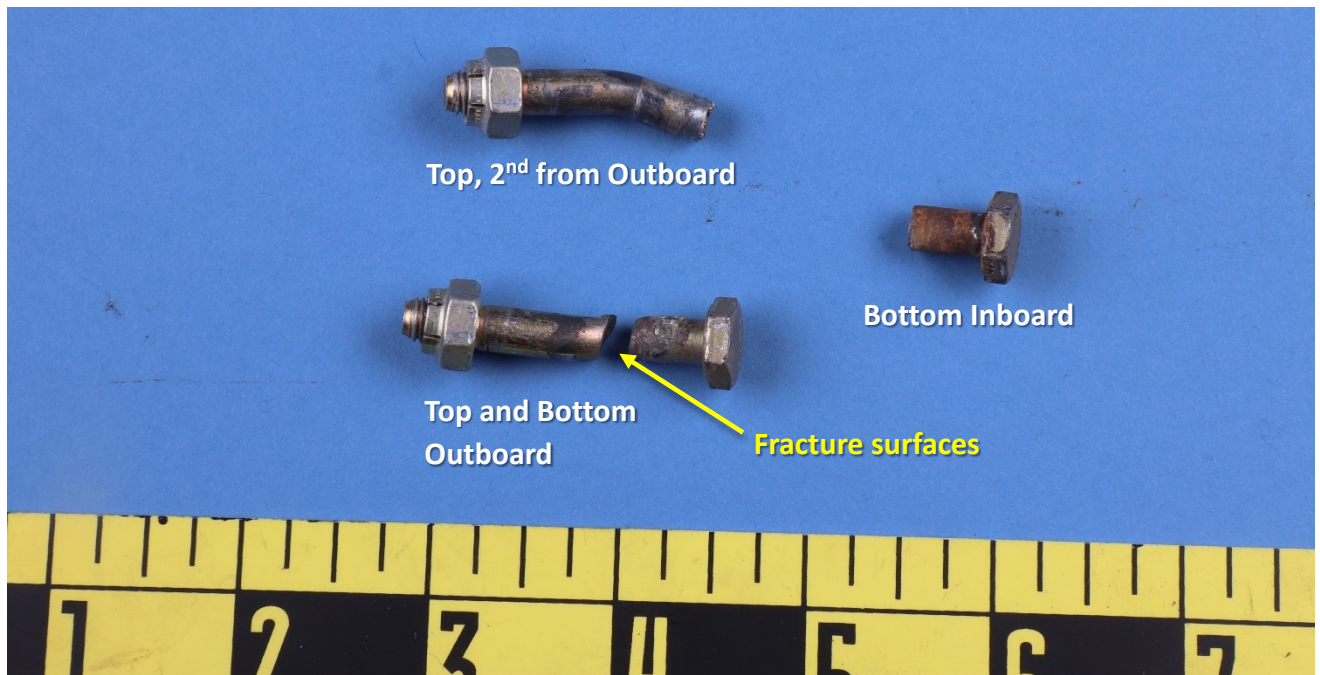


Figure 1 – The four bolt remnants, as received, labeled as received.



Figure 2 – Side view of the bottom inboard bolt remnant, as received.



Figure 3 – The head markings on the bottom inboard bolt remnant.



Figure 4 – Fracture surface from the inboard bottom bolt, as received.

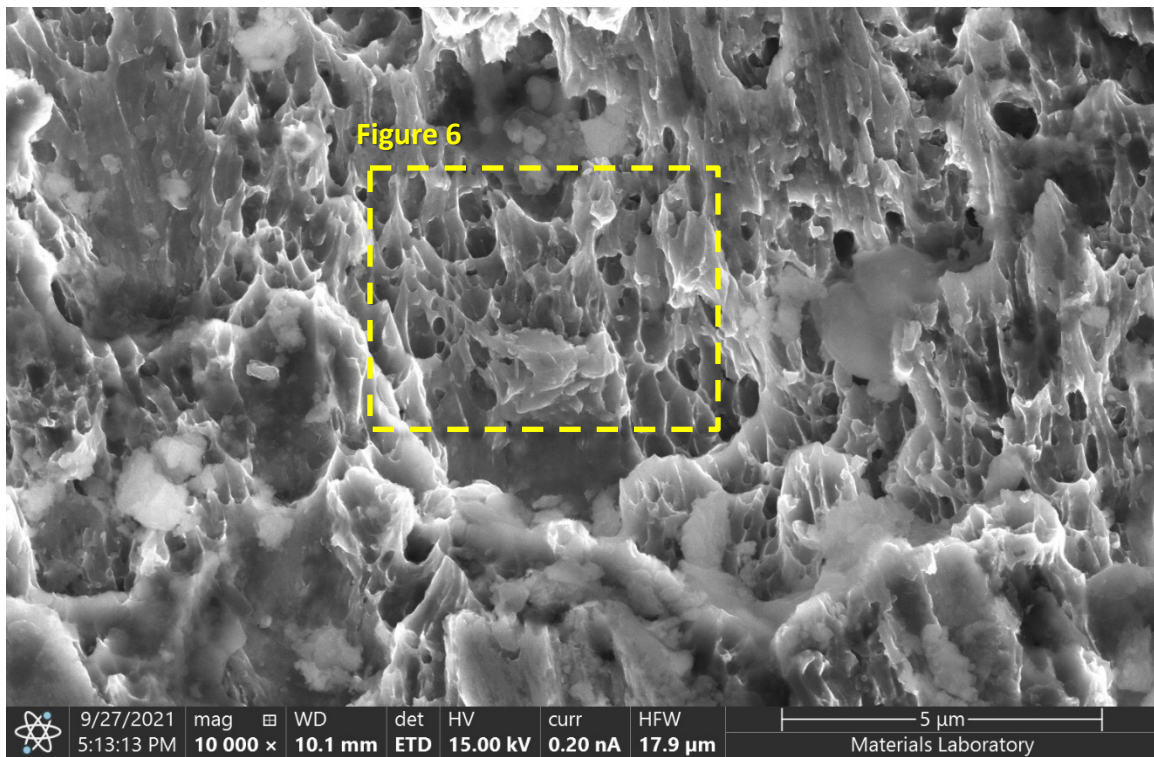


Figure 5 – Secondary electron (SE) micrograph of a typical area of the inboard bottom bolt remnant fracture surface.

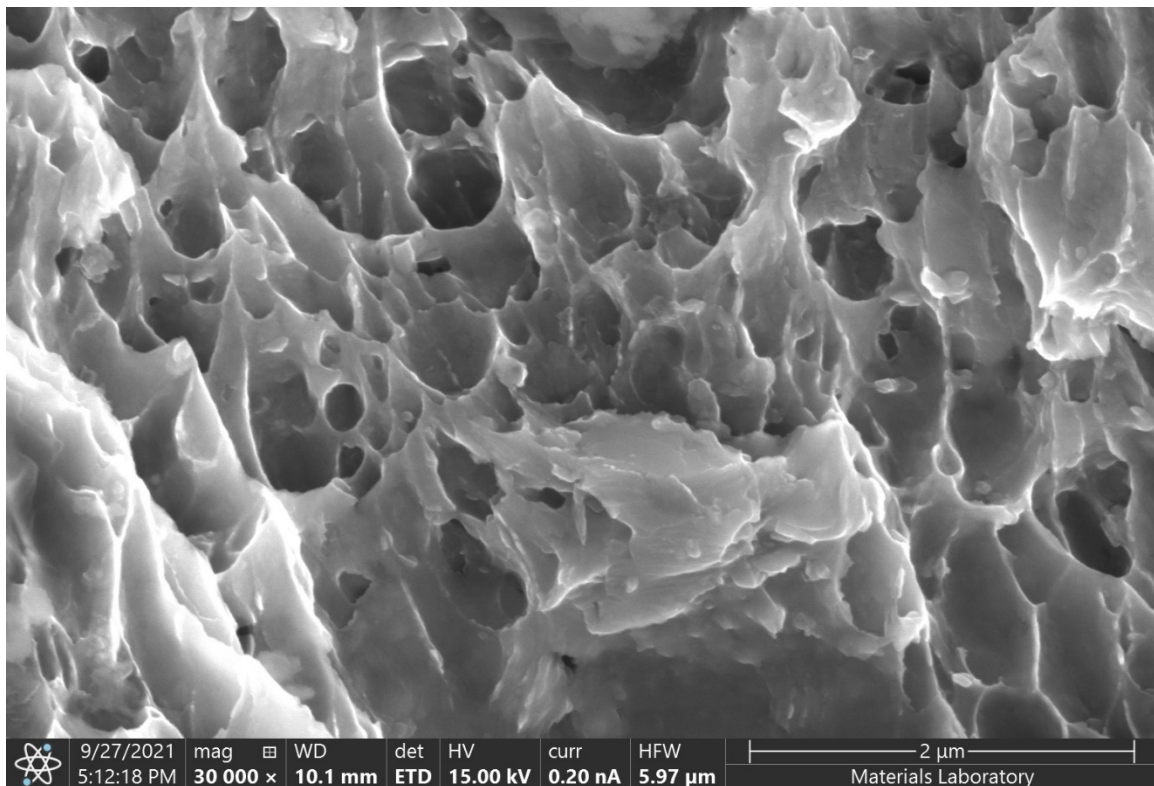


Figure 6 – SE micrograph of dimpled rupture from the boxed area in Figure 5.



Figure 7 – Side view of the bottom outboard bolt remnant.



Figure 8 – Side view of the top outboard bolt remnant.

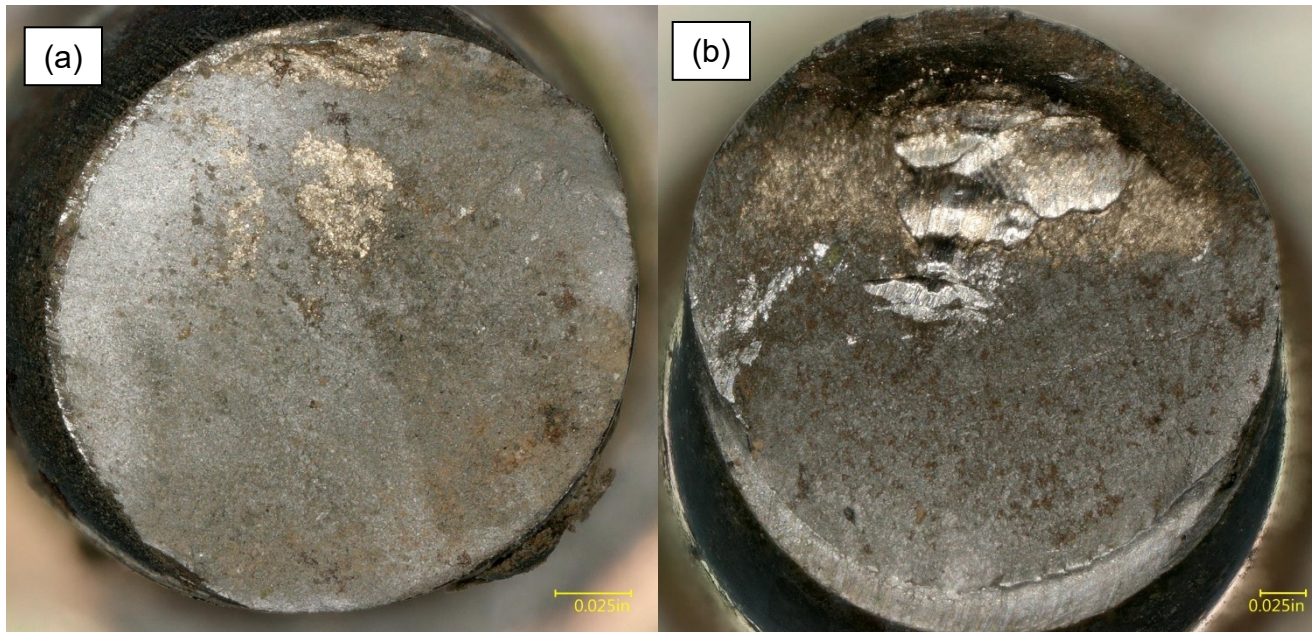


Figure 9 – The mating fracture surfaces of the outboard bolt remnants from (a) the bottom and (b) top faces.

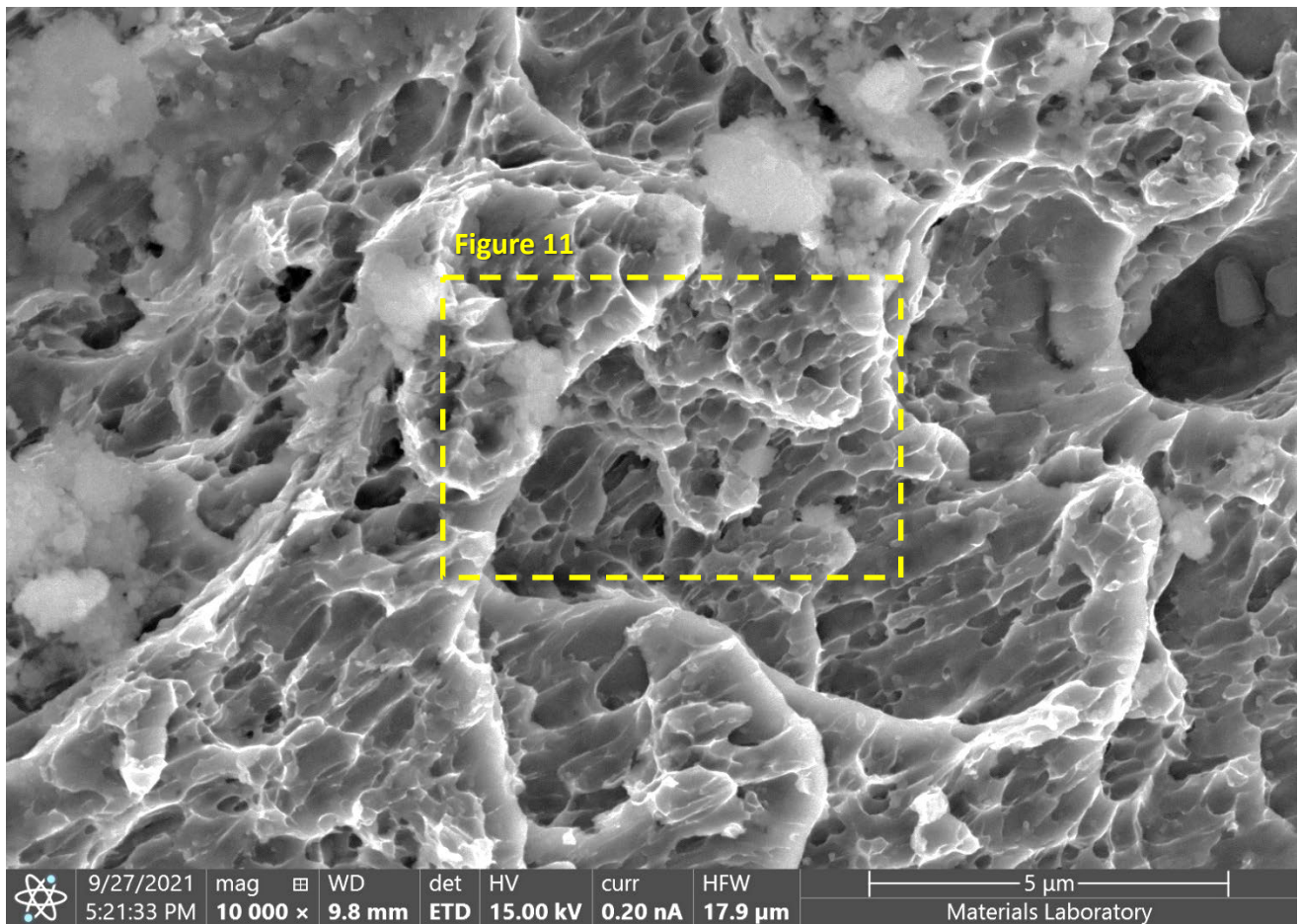


Figure 10 – SE micrograph of a typical area of the top outboard fracture surface.

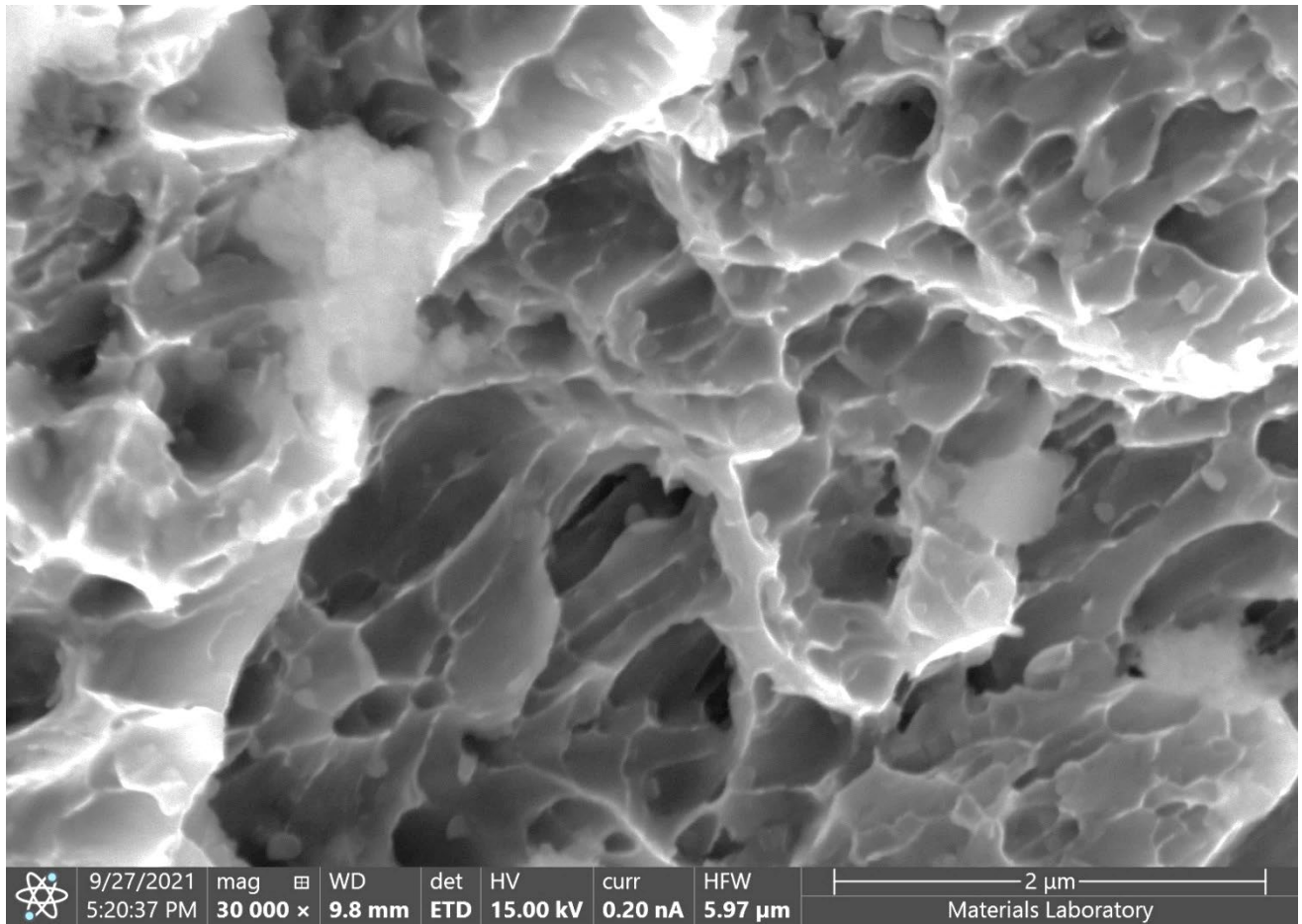


Figure 11 – SE micrograph of a closer area of the dimpled rupture in the boxed area in Figure 10.



Figure 12 – Side view of the top bolt remnant, second from outboard.



Figure 13 – View of the fracture surface of the top bolt remnant, second from outboard.

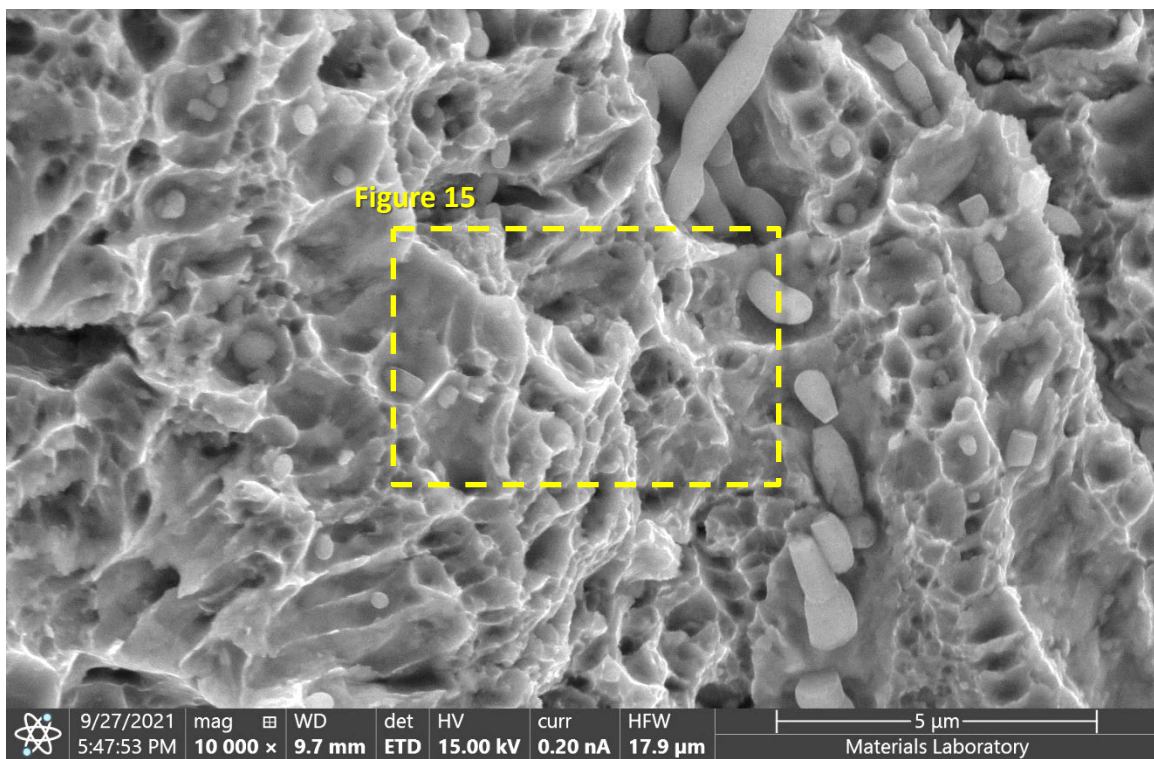


Figure 14 – SE micrograph of a typical undamaged area from the fracture surface in Figure 13.

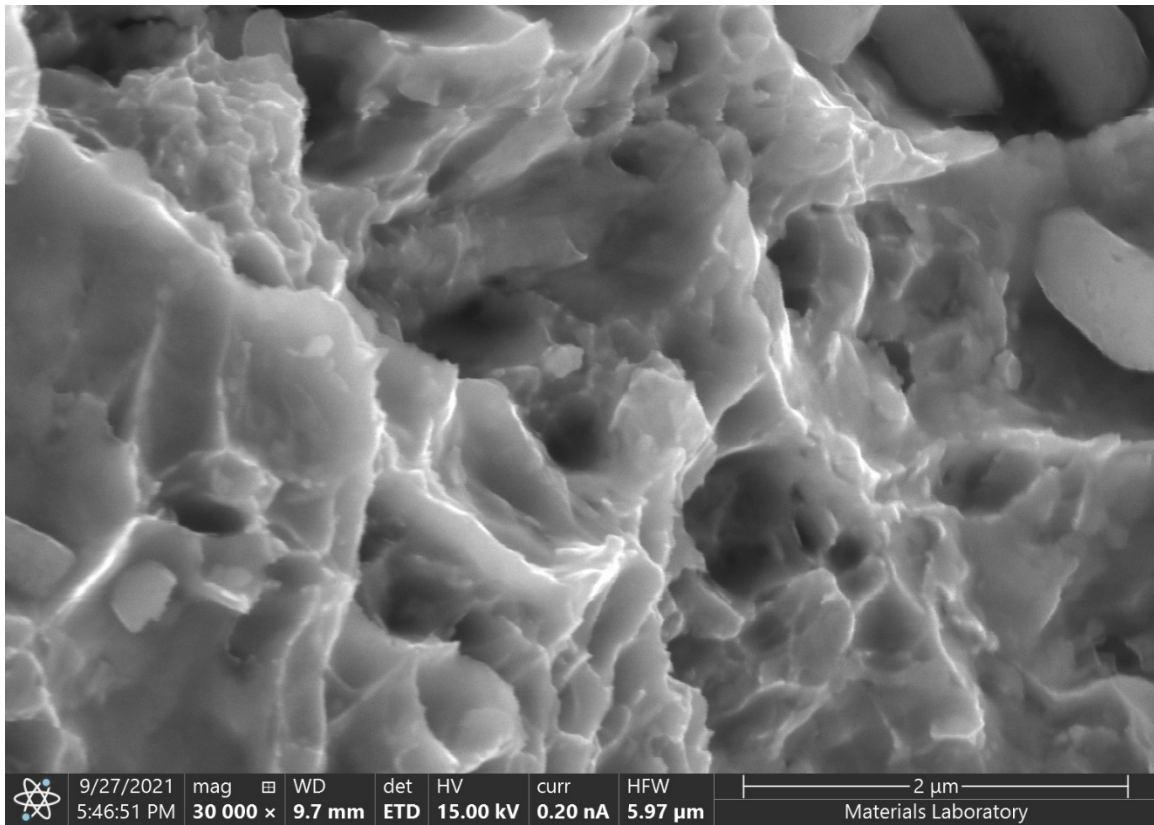


Figure 15 – SE micrograph of dimpled rupture in the boxed area in Figure 14.