

NATIONAL TRANSPORTATION SAFETY BOARD

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



April 12, 2021

MATERIALS LABORATORY FACTUAL REPORT

Report No. 21-014

A. ACCIDENT INFORMATION

Place : Steele, Missouri
Date : May 22, 2020
Vehicle : Piper PA-28-180
NTSB No. : CEN20LA189
Investigator : John Brannen, AS-CEN

B. COMPONENTS EXAMINED

Connecting rod assembly pieces with connecting rod bolt piece and nut and piston assembly piece with piston pin.

C. DETAILS OF THE EXAMINATION

An overall view of the submitted piston assembly with piston pin and connecting rod assembly pieces with a connecting rod bolt piece and nut is shown in figure 1. The piston was fractured around a portion of the skirt and showed impact damage corresponding to contact with the connecting rod. The connecting rod was fractured at the big end on both sides of the strap, and a strap piece with mating fracture features was included as shown in figure 1. The connecting rod bolt was fractured, and the attached nut was intact.

Close views of fracture surfaces through the connecting rod strap are shown in figures 2 and 3. For reference, the sides of the connecting rod were arbitrarily labeled A and B, where the A side is shown facing the camera in figure 1. Portions of the fracture surfaces on each arm of the strap were in planes perpendicular to the hoop direction and had curving crack arrest lines, features consistent with fatigue. Fatigue origins were located at the outer sides of the strap around the recess for the connecting rod bolt nut as indicated with arrows and brackets in figures 2 and 3. On the A side, the fatigue origins on each arm appeared to be located at the intersection between the recess and the outer surface. On the B side, ratchet marks were observed consistent with multiple origins located along the recess as indicated with brackets in figures 2 and 3. Origin areas on both arms were damaged by post-fracture contact.

Dashed lines in figures 2 and 3 indicate the approximate location of fatigue boundaries consistent with fatigue cracks propagating through most of the thickness on each arm. Portions of the fatigue boundaries were damaged by post-fracture contact, particularly on the arm shown in figure 2.

The big end of the connecting rod was tinted dark consistent with high heat exposure at the bearing journal contact area (see figure 1). The bearing contact face shown in figure 4 was tinted dark and had orange deposits on the surface consistent with bearing material that had fused to the connecting rod. Much of the bearing face on the strap piece shown in figure 5 was obliterated by heavy contact damage, but an area outlined in figure 5 showed heat tinting and circumferential sliding contact marks.

The connecting rod strap piece was cleaned using a soft-bristle brush and a solution of Alconox and water followed by ultrasonic cleaning in a bath of the Alconox solution. The split line for the strap piece where it mated to the cap is shown in figure 6 after cleaning. Pit-like features consistent with fretting contact damage were noted on the split-line face as indicated in figure 6. The connecting rod nut seat on the opposite end of the connecting rod strap piece is shown in figure 7. Overall, the connecting rod bolt hole was deformed to an oblong shape. Contact marks consistent with contact with two threads from the connecting rod bolt were observed in the connecting rod bolt hole. The thread impressions were located on the bearing side and the outer side of the hole where the hole was deformed to the smaller diameter, and gaps between the impressions were present on the A and B sides of the hole (see figure 7).

The nut was trapped on the threaded end by deformed threads on either side of the nut. To facilitate an examination of the threads on the nut and bolt, a water-cooled abrasive saw was used to cut the nut on two sides to remove it from the bolt. The sectioned bolt and nut were submerged in a bath of acetone and cleaned using an ultrasonic cleaner. A view of the seating face of the nut after cleaning is shown in figure 8. A shallow circumferential groove in the copper coating was observed on the seating face as indicated. The contact flanks of the nut threads, shown in figure 9, were examined for contact with the mating connecting rod bolt threads. Circumferential contact marks were observed on most of the thread flanks. However, rough surfaces with limited circumferential contact marks were observed on some of the threads, particularly on the three threads closest to the seating face.

The nut half shown at the left in figure 9 was examined using a scanning electron microscope (SEM), and an SEM image of the contact flanks for several threads near the nut seating face is shown in figure 10. The contact flanks appeared to have smeared metal features that were deformed in the radial direction across the flanks.

According to engine maintenance records, the engine was last overhauled on September 11, 1998 and was installed on the airplane 17 days later. The engine had accumulated approximately 1,064 hours time in service since overhaul.

Matthew R. Fox, Ph.D.
Senior Materials Engineer

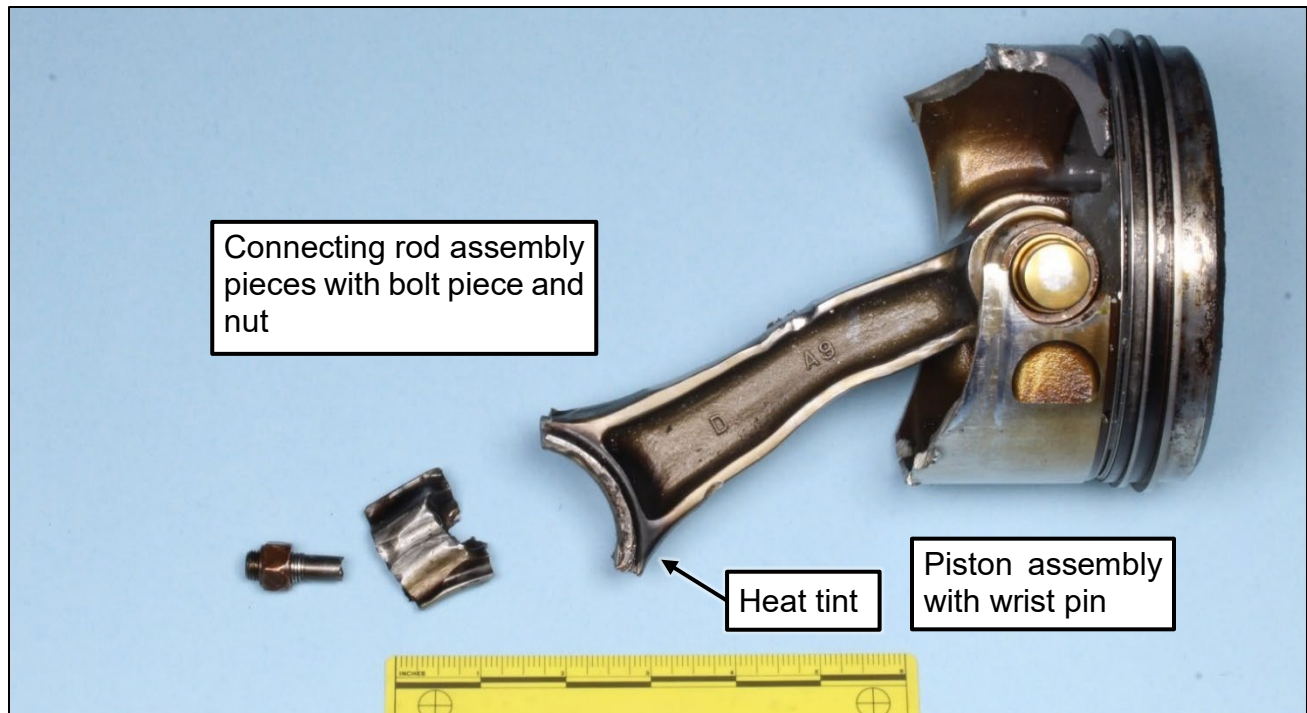


Figure 1. Photograph of the submitted components.

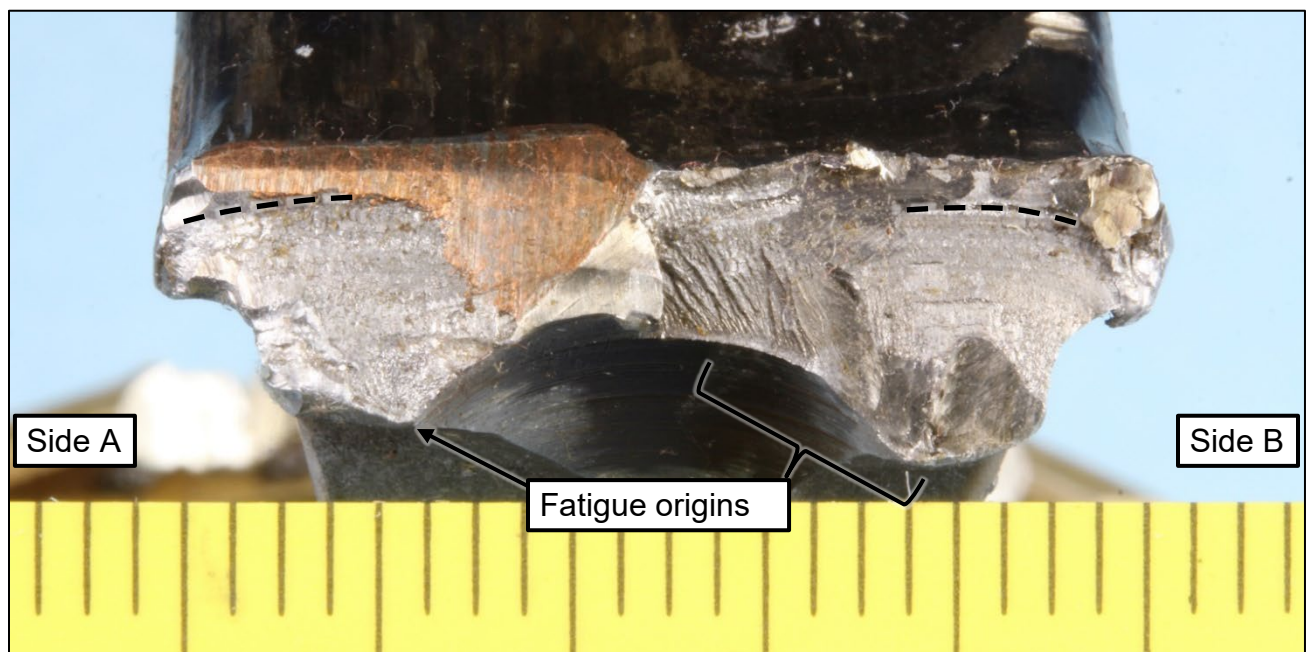


Figure 2. Close view of fracture features on the connecting rod strap. Dashed lines indicate portions of the fatigue boundary that remained identifiable.

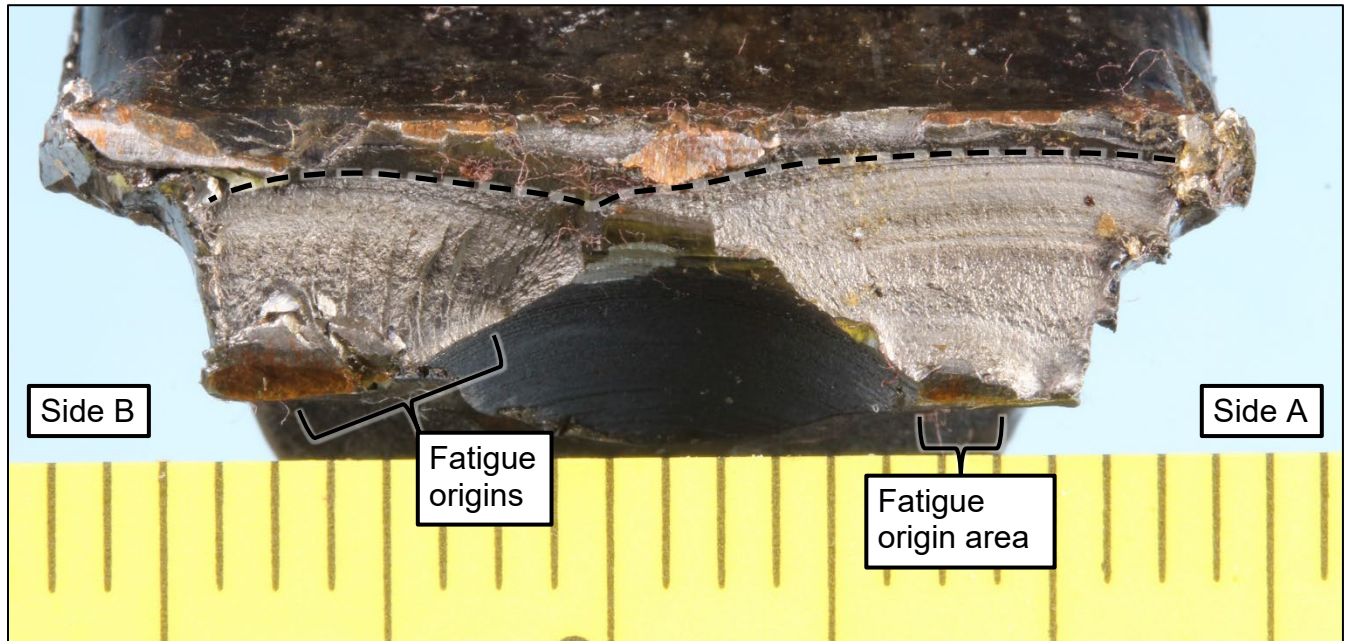


Figure 3. Fracture features on the opposite side of the connecting rod strap. A dashed line indicates the fatigue boundary.



Figure 4. Bearing contact face on the connecting rod strap showing heat damage, circumferential sliding marks, and galled bearing material on the surface.



Figure 5. Bearing contact face on the connecting rod strap piece showing heat tinting and circumferential sliding contact marks in the area outlined with a dashed line.

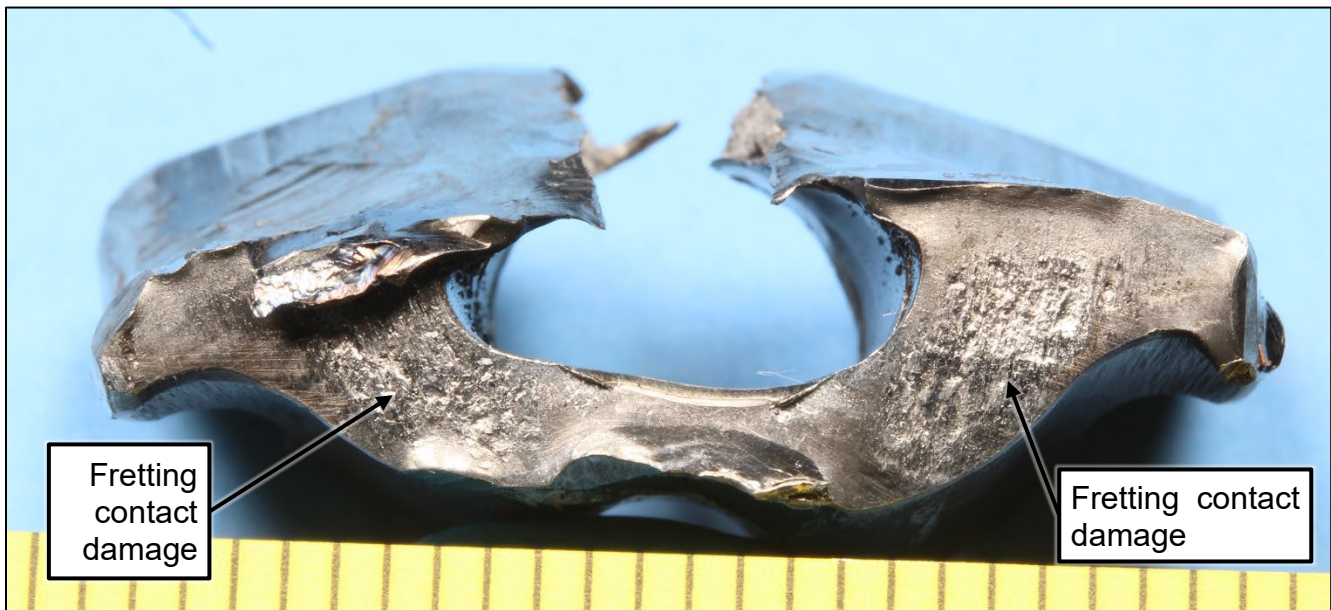


Figure 6. Cleaned connecting rod strap showing fretting contact damage on the split-line face.

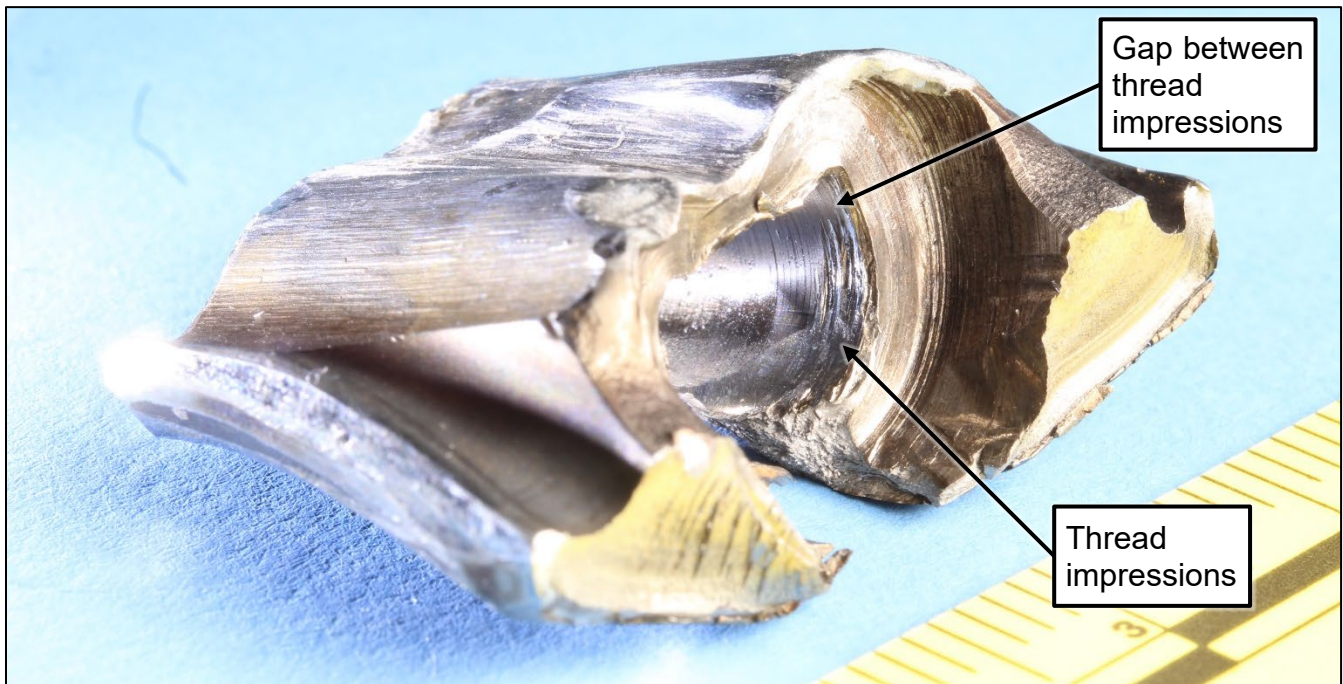


Figure 7. Connecting rod strap piece showing thread impressions on the bore of the connecting rod bolt hole.

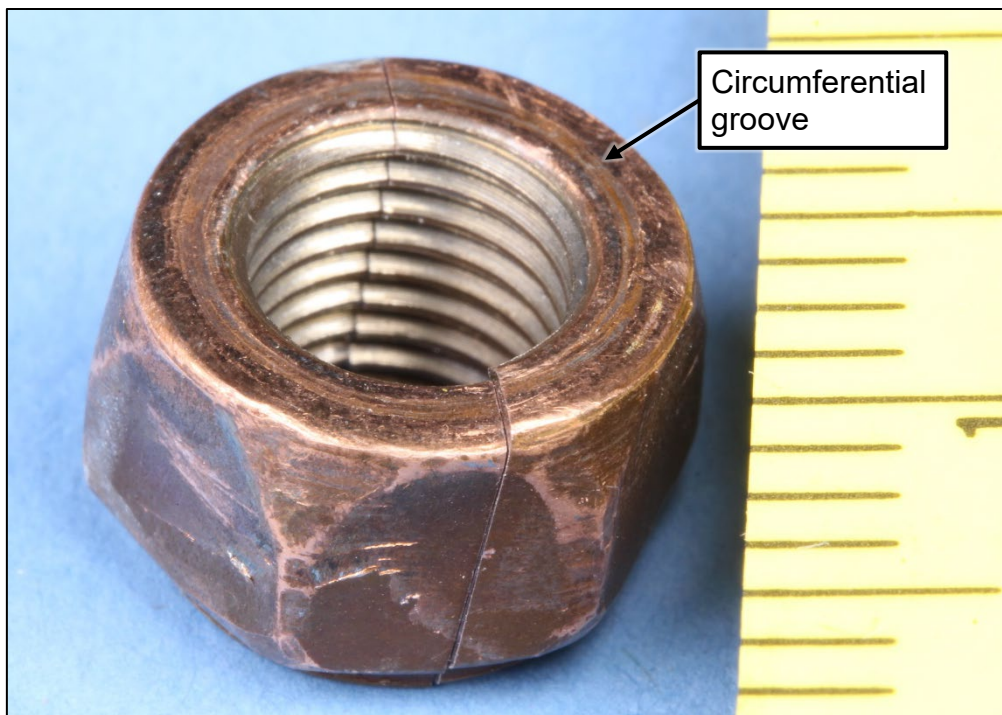


Figure 8. Connecting rod nut shown after sectioning from the bolt and cleaning with acetone in an ultrasonic cleaner. A shallow circumferential groove on the seating face is indicated.

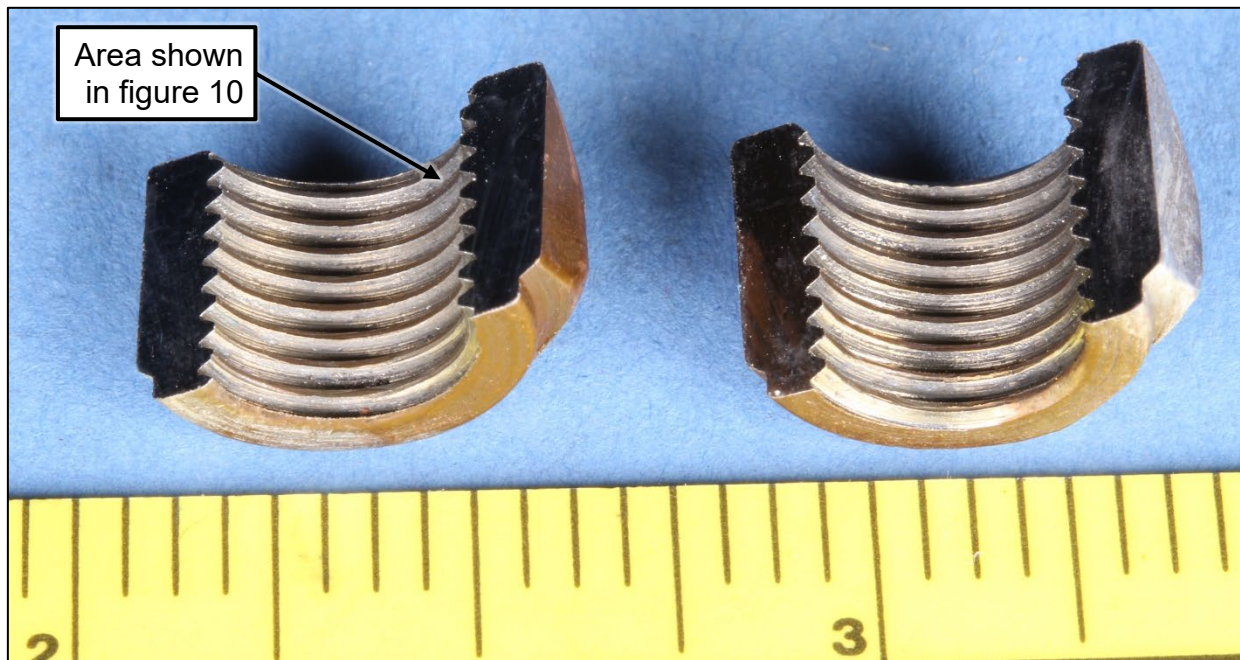


Figure 9. Overall view of the contact flanks of the sectioned and cleaned connecting rod nut. Irregular surface roughness was observed, particularly on the three thread flanks closest to the nut seating face.

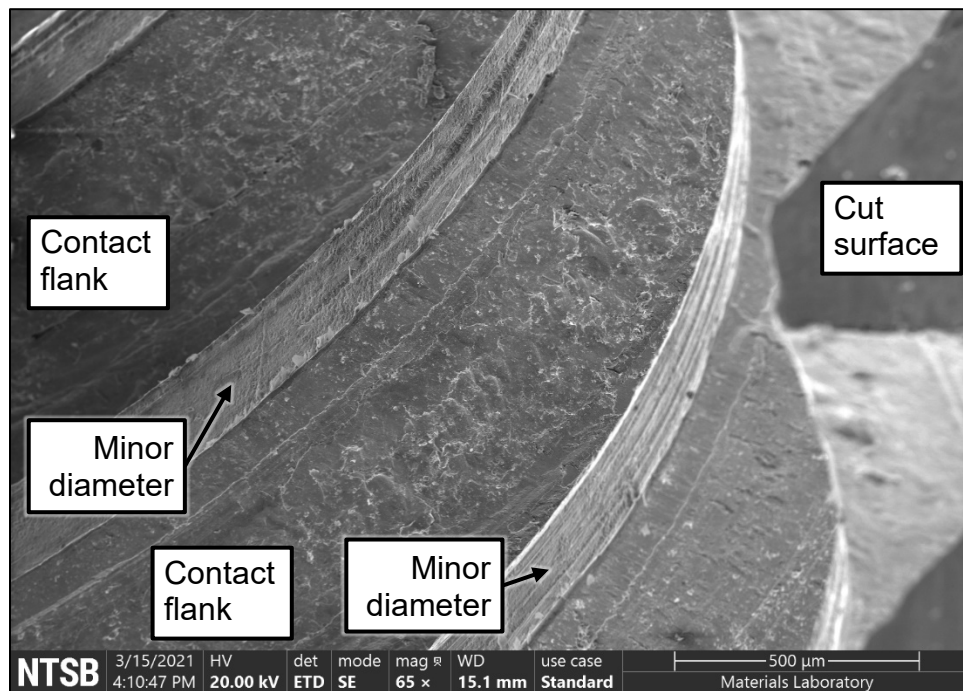


Figure 10. SEM image of smeared metal features on the contact flanks of threads near the nut seating face.