

NATIONAL TRANSPORTATION SAFETY BOARD

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



November 21, 2017

MATERIALS LABORATORY FACTUAL REPORT

Report No. 17-080

1. ACCIDENT INFORMATION

Place : Dayton, Tennessee
Date : June 20, 2016
Vehicle : Rockwell International 112A, N
NTSB No. : ERA16LA226
Investigator : Heidi Kemner, AS-ERA

2. COMPONENTS EXAMINED

Parts of an engine driven fuel pump

3. DETAILS OF THE EXAMINATION

On June 20, 2016, about 1240 eastern daylight time, a Rockwell International 112A impacted trees during a forced landing following a total loss of engine power near Dayton, Tennessee. The private pilot received serious injuries. The pilot stated that the engine had lost power during flight. A postaccident examination revealed that the engine remained attached to the fuselage, and the propeller remained attached to the engine. The engine was retained, and parts of an engine-driven fuel pump were submitted to the NTSB Materials Laboratory to further examination.

Figure 1 shows the fuel pump components, as received. The pump body had been separated from the unit assembly and the fittings had been removed prior to receipt. There were no noted features or witness marks on the removed fittings or on the outer body surfaces of the pump components. Of note was a fractured remnant attached to the diaphragm spindle, shown in Figure 2. This remnant matched a circular fracture on the diaphragm retainer still present adjacent to the pushrod arm inside the pump body, shown in Figure 3.

The retainer inside the pump body is highlighted in Figure 4, and its fracture surface is illustrated in Figure 5. The left side of the retainer in Figure 4 was bent (upward towards the reader) facing towards the unit assembly. The fracture was generally circular in orientation, matching that of the remnant on the spindle. The general morphology of the fracture was slanted, with indications of localized plastic deformation adjacent the fracture surface. Witness marks were present on this side of the retainer, consistent with rubbing or fretting against the pushrod arm.

The retainer remnant on the diaphragm spindle is shown in Figure 6. The top of the flared end of the spindle exhibited rub and impact marks, as shown in Figure 6b. No other indications of damage to the spindle were observed.

The retainer remnant is highlighted in Figures 7 and 8, as received. This remnant exhibited a circumferential fracture surface, consistent with the mating surface of the retainer in the pump body. The fracture surface of the remnant was generally slanted in orientation. One side of the remnant fracture jetted out, consistent with a tearing motion on that side (Figure 8). The bottom side of the remnant was found pushed inward towards the spindle and the spring retainer.

Figure 9 shows the remnant after removal from the spindle and cleaning. The remnant was positioned in Figure 9 at an angled orientation. The fracture surface exhibited features such as river patterns and chevron marks. These features were consistent with a fracture having occurred on one side of the retainer, and then advancing around either side of the retainer cavity. The portion of the retainer remnant 180° from the start of the fracture was the last to fracture, and it exhibited features consistent with plastic deformation from being torn away. The dashed arrows in Figure 9 illustrate the direction of fracture of the retainer.

In addition, the area below the fracture on the retainer remnant exhibited a circumferential region of longitudinal wear or rub marks (see Figure 9). The location of these marks was consistent with the location of the pushrod arm clevis.

The remnant was inspected using a scanning electron microscope (SEM). The fracture surface exhibited either slanted fracture faces or a local necking/tapering adjacent to the fracture surface, as shown in Figure 10. Much of the fracture surface was damaged or obliterated by smearing, consistent with post fracture contact with adjacent components. The areas not damaged exhibited dimple rupture, as exemplified in Figure 11. No indications of other failure modes were observed on the fracture surfaces.

Erik M Mueller
Materials Research Engineer

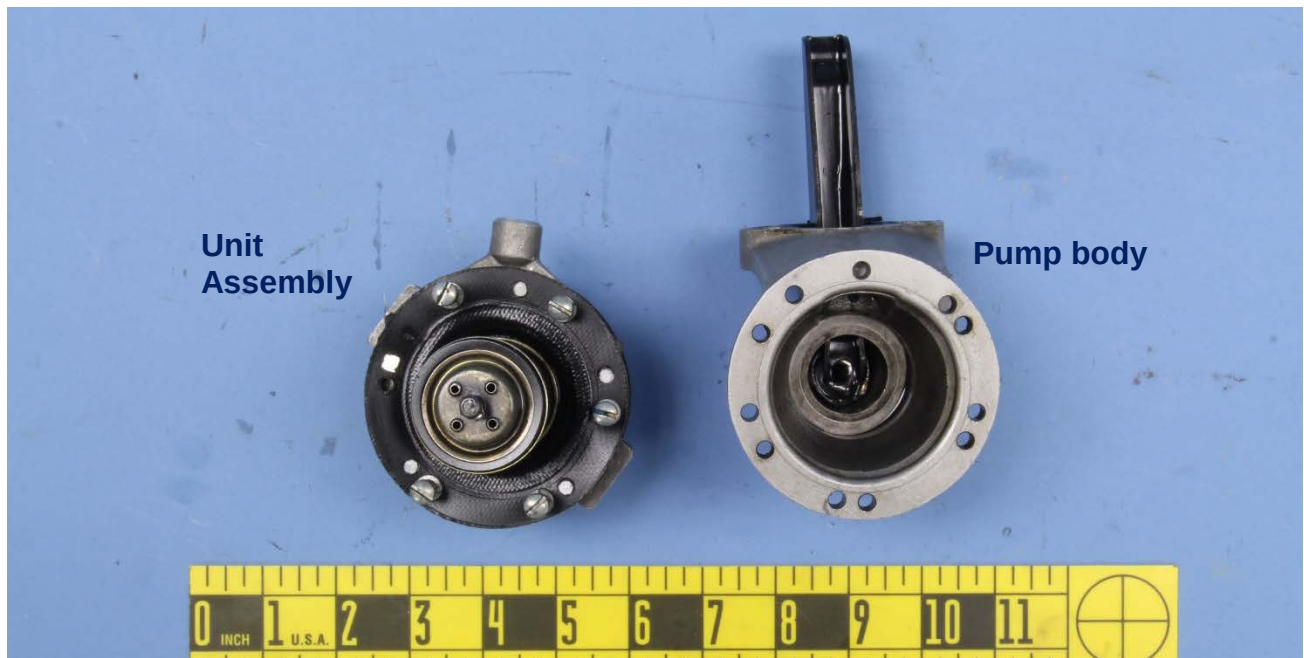


Figure 1 – The components of the fuel pump (less the fittings), as received. The removed fittings are not shown.

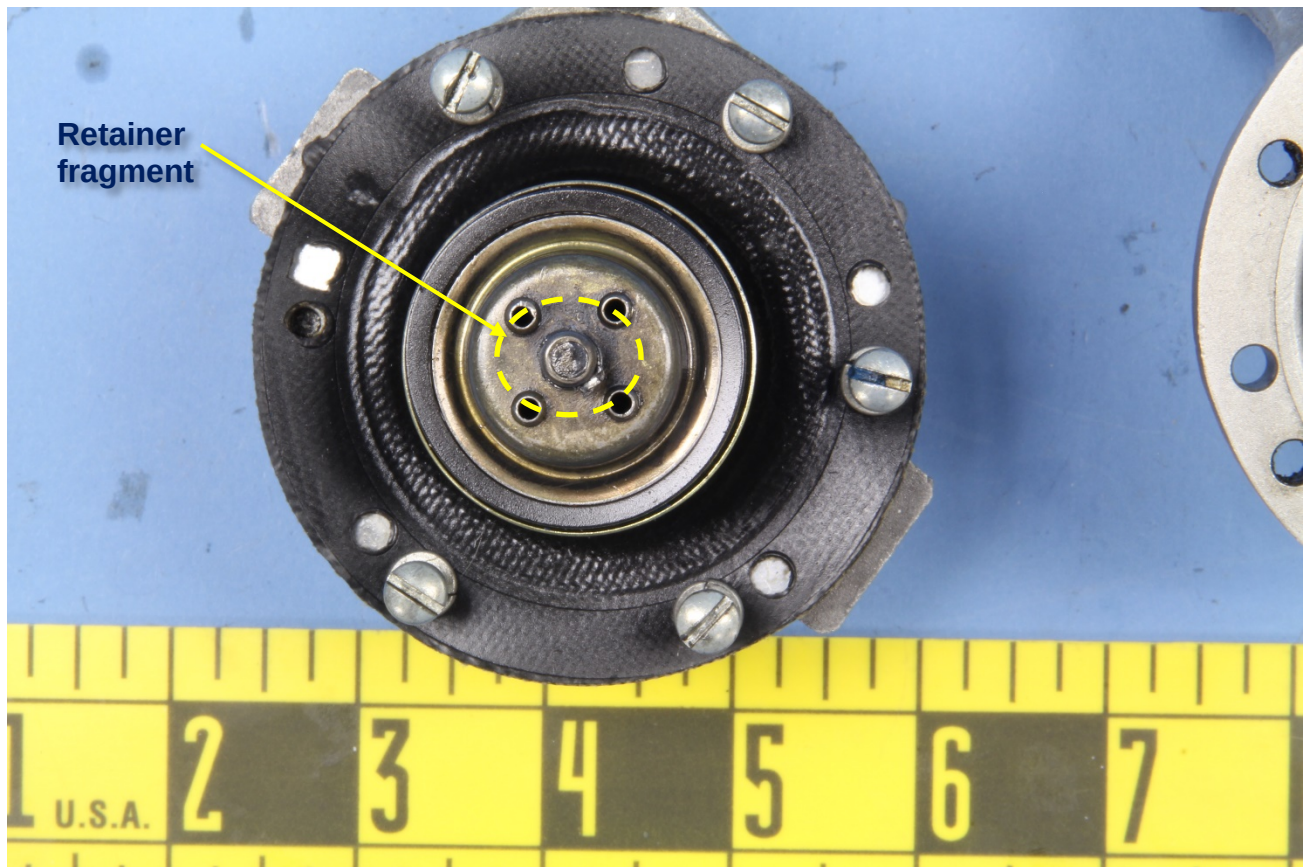


Figure 2 – Closer view of the interior of the unit assembly, as received.

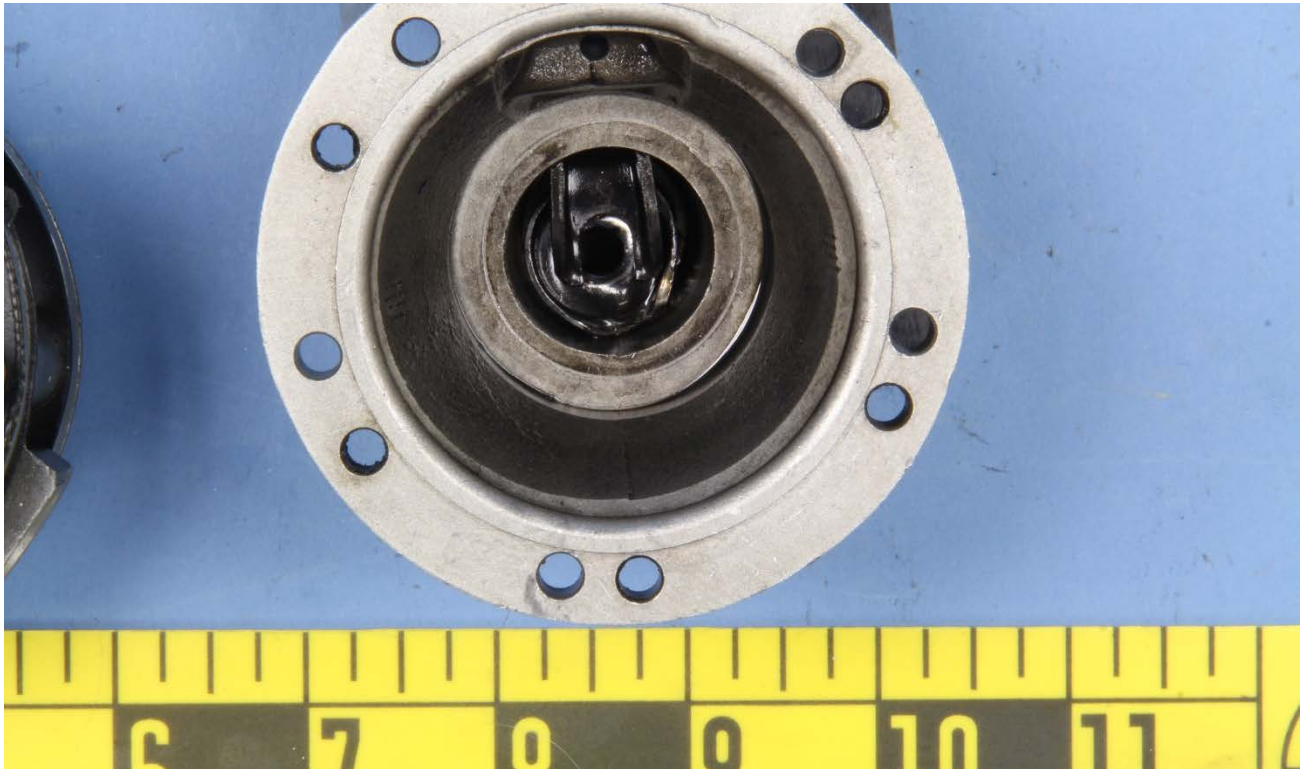


Figure 3 – A view of interior of the pump body, as received.

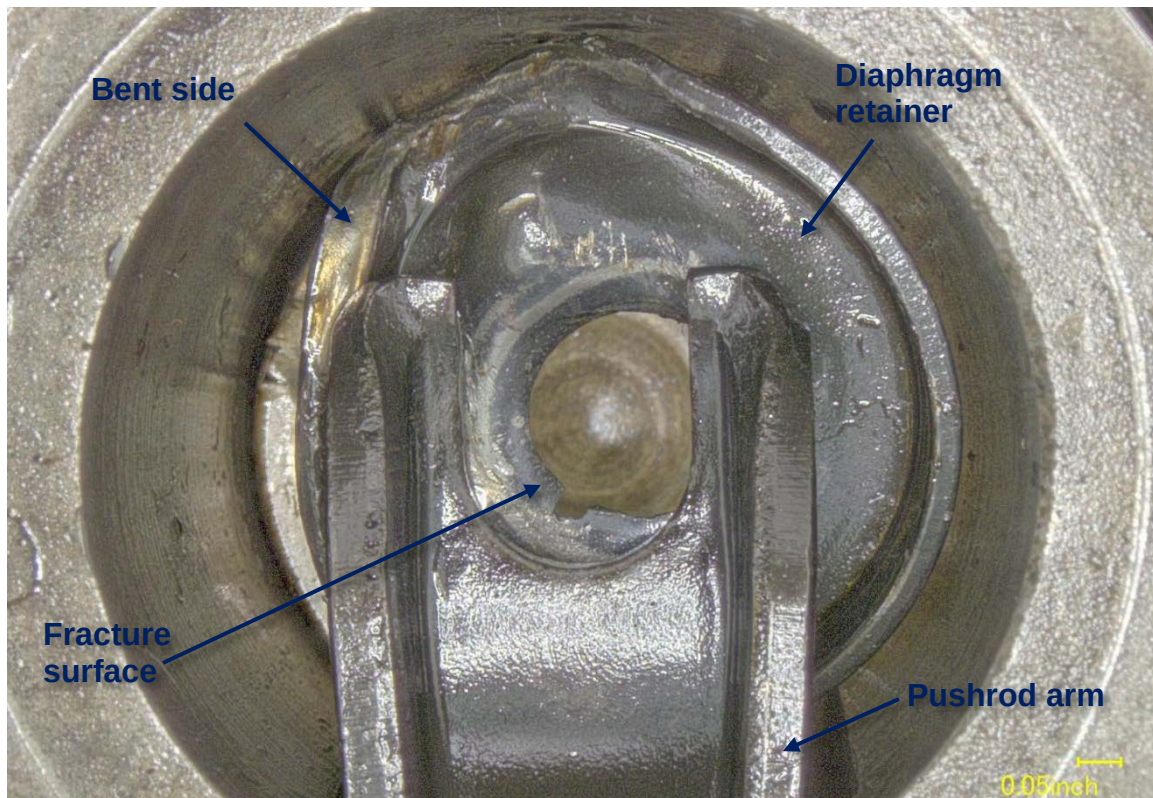


Figure 4 – Closer view of the interior of the pump body, showing a damaged diaphragm retainer.



Figure 5 – Closer view of the diaphragm retainer from Figure 4, showing a slanted circular fracture.

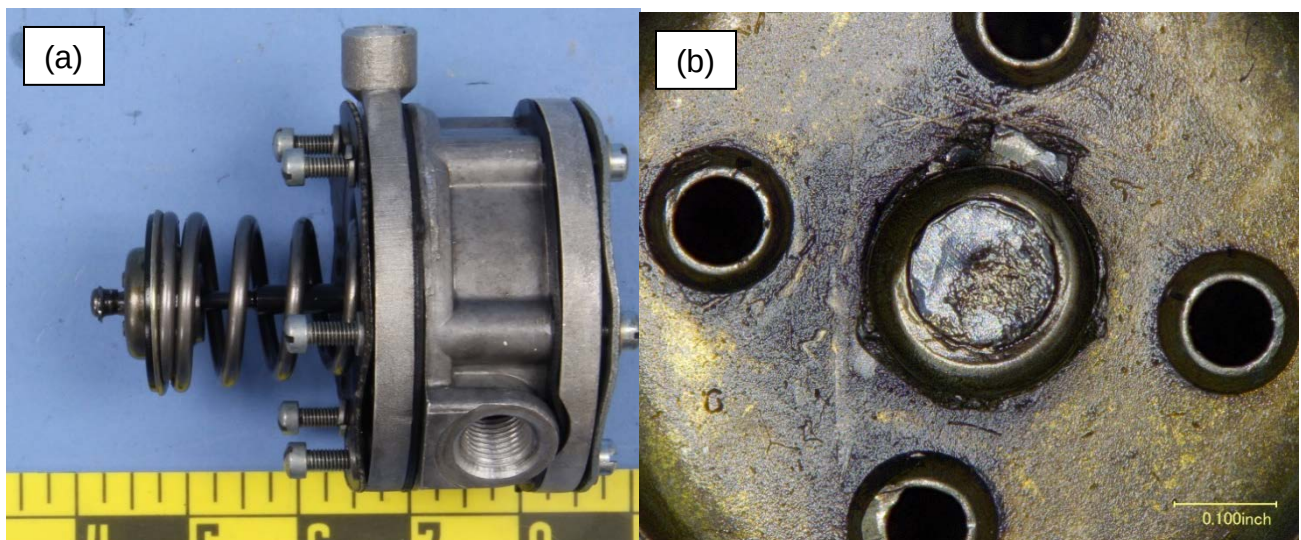


Figure 6 – The unit assembly from (a) the side and (b) the top, showing a retainer remnant.

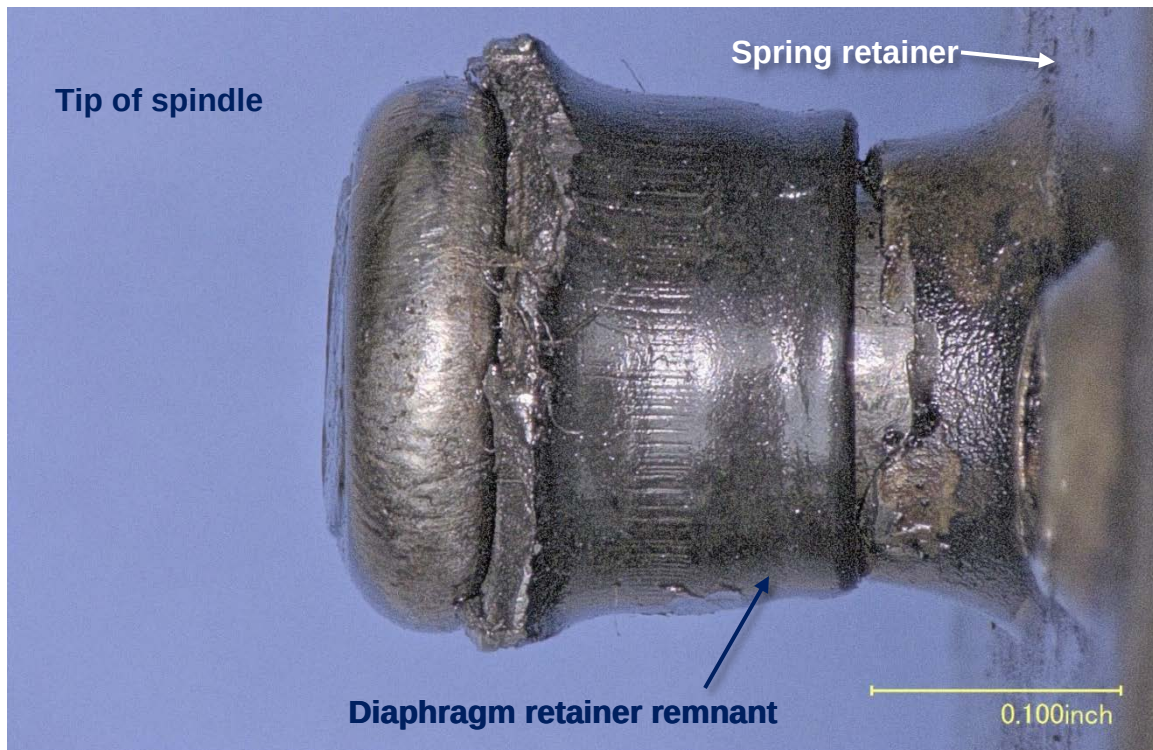


Figure 7 – A closer view of the diaphragm retainer remnant in shown in Figure 6a.

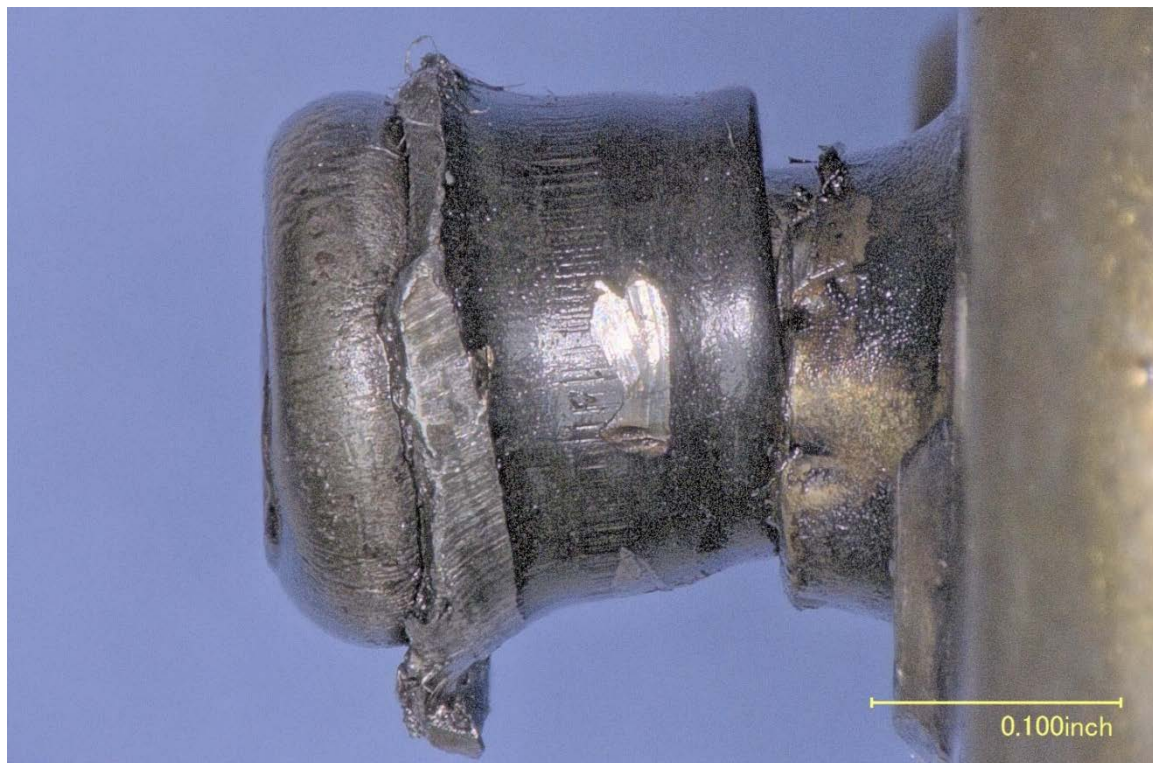


Figure 8 – The retainer remnant viewed from the side, rotated 90° from Figure 7.

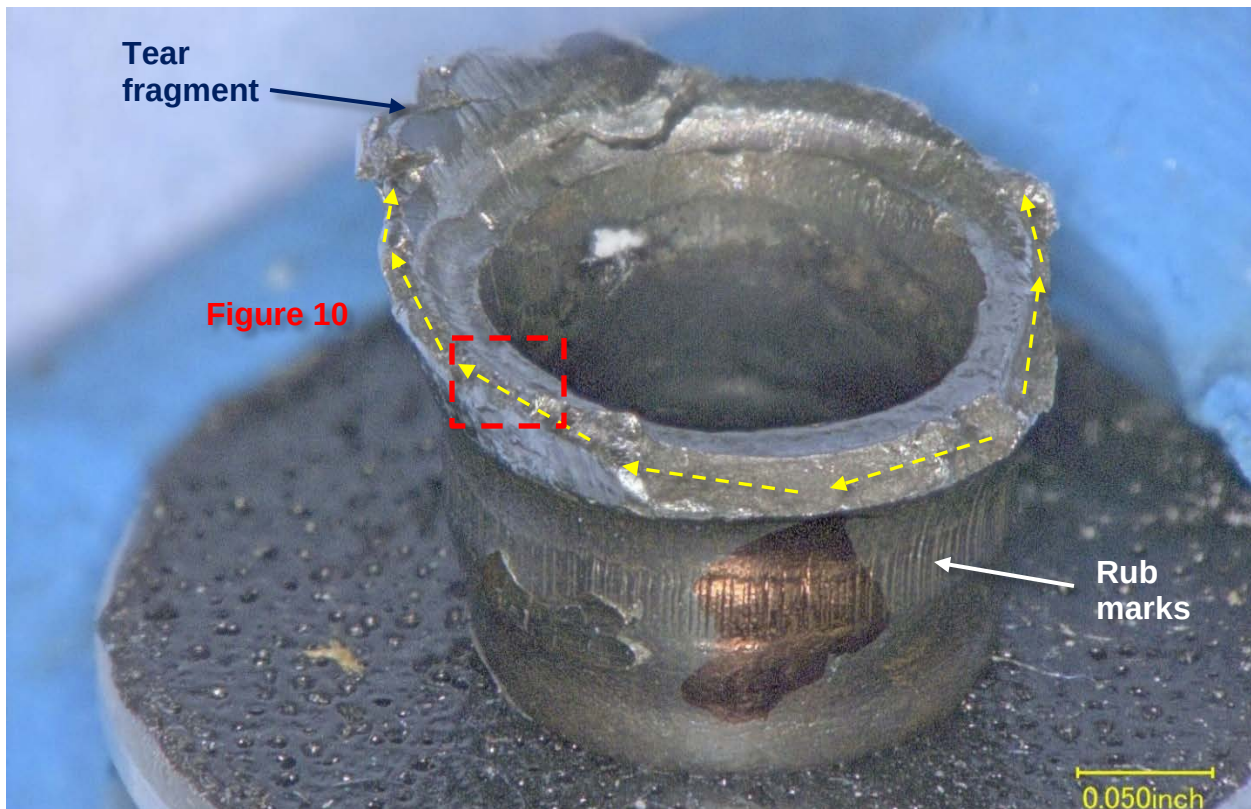


Figure 9 – The retainer remnant, after removal and cleaning. The arrows show the fracture direction(s). The red dashed box is shown in Figure 10.

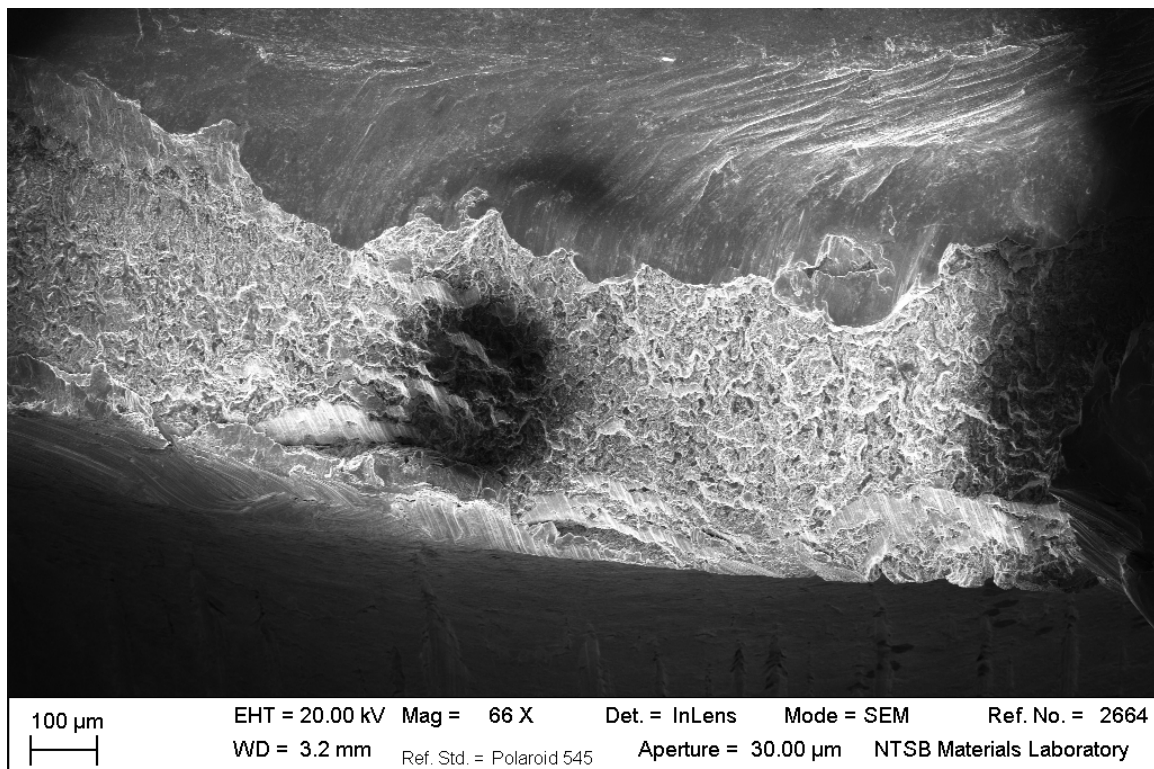


Figure 10 – Secondary electron (SE) micrograph of the remnant fracture surface.

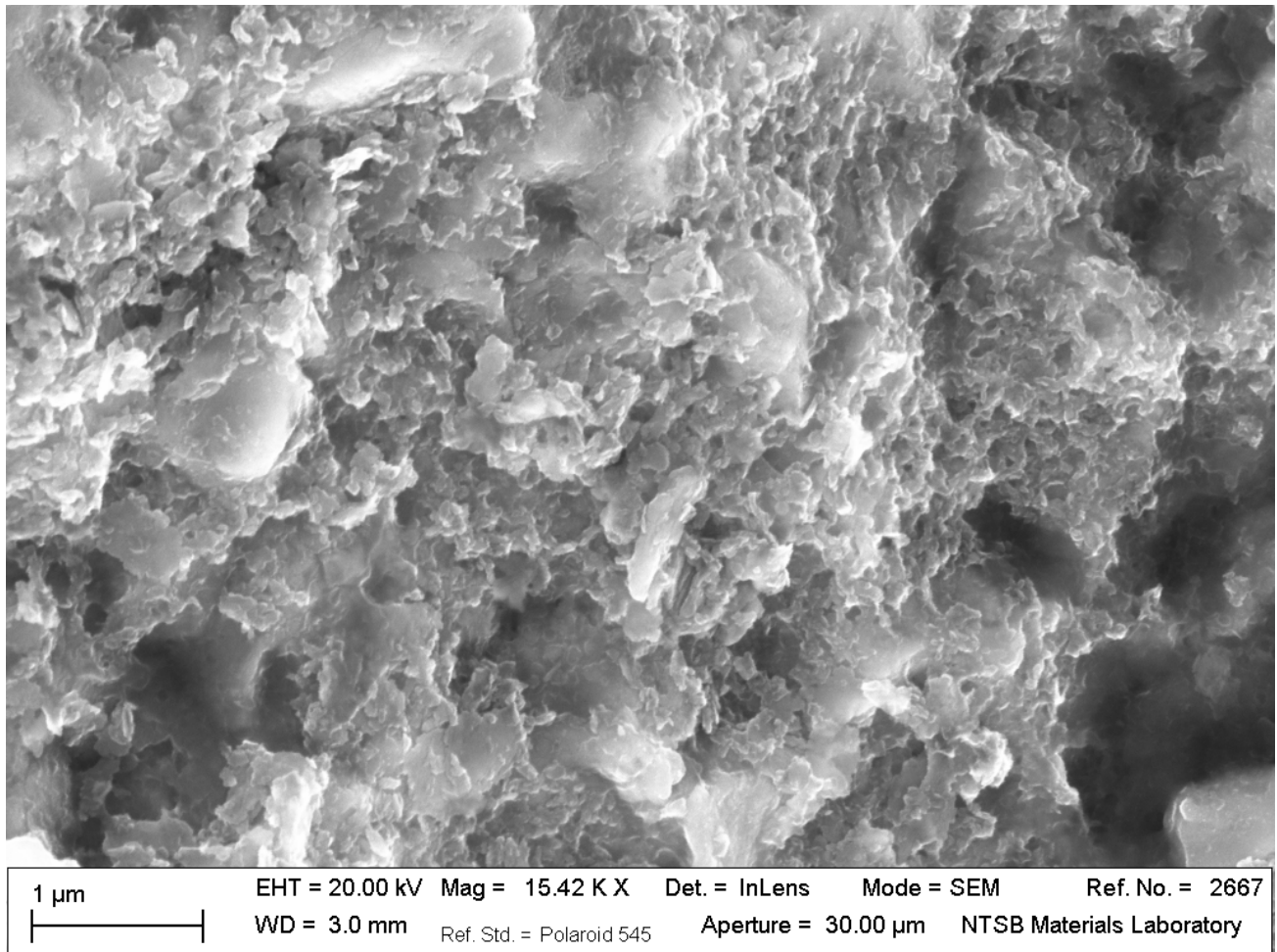


Figure 11 – SE micrograph of the fracture surface in , showing oxidized featured consistent with dimple rupture.