

NATIONAL TRANSPORTATION SAFETY BOARD

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



August 5, 2019

MATERIALS LABORATORY FACTUAL REPORT

Report No. 19-044

A. ACCIDENT

Place : Southold, NY
Date : June 8, 2019
Vehicle : Beech A36 (N8014T)
NTSB No. : ERA19FA189
Investigator : Millicent Hill (AS-ERA)

B. COMPONENTS EXAMINED

Fuel Pump Drive Coupling

C. DETAILS OF THE EXAMINATION

The purpose of this investigation is to evaluate the fracture surfaces of a fuel pump drive coupling from a Beech A36 aircraft. Using a Thermo Scientific Niton XL3t Hand Held Alloy Analyzer, the coupling material was found to be type 4140 alloy steel. Using a Wilson Rockwell Hardness Tester, the coupling hardness was found to be between 38.3 and 41.3 HRC. Overall views of the two halves of the submitted coupling are shown in Figures 1 and 2. The coupling had separated through the round shear section between the large and small square ends.

Both fracture surfaces were immersed in an acetone ultrasonic cleaning bath, then in Evapo-Rust® (Harris International Laboratories, Springdale, Arkansas) to remove any grease and corrosion product present. Figures 3 and 4 show digital microscope images of the two fracture surfaces with each of the four sides labeled. Both fracture surfaces were relatively flat. No necking or bending deformation was observed to the shear section.

The large end of the coupling was also immersed in a toluene cleaning bath to remove grease present along the outer circumference of the round shear section. Minor anomalies were present within the machining marks on the round shear section, however they did not contribute to the failure of the part. The anomalies were most likely due to machining imperfections. Figure 5 shows a digital microscope image of the round shear section machining marks with the anomalies on the large end of the coupling. Wear marks were also present on all four sides of both ends of the coupling as shown in Figures 6 and 7.

A field emission scanning electron microscope (FE-SEM) was used to examine the coupling fracture surfaces. Overall FE-SEM montage fractographs of both fracture surfaces are shown in Figures 8 and 9. There were visible ratchet marks at the outer diameter of the small end fracture surface as shown in Figure 10. The multiple ratchet marks present are consistent with multiple initiation fatigue cracking. Striations were also visible on both fracture surfaces, which is also consistent with fatigue fracture. Figures 11 and 12 show fatigue striations present on both the small and large end fracture surfaces. Microvoid coalescence was also present on both fracture surfaces consistent with overstress separation towards the center of the shear section. This is shown in Figures 13 and 14.

Aphrodite Strifas
Student Trainee
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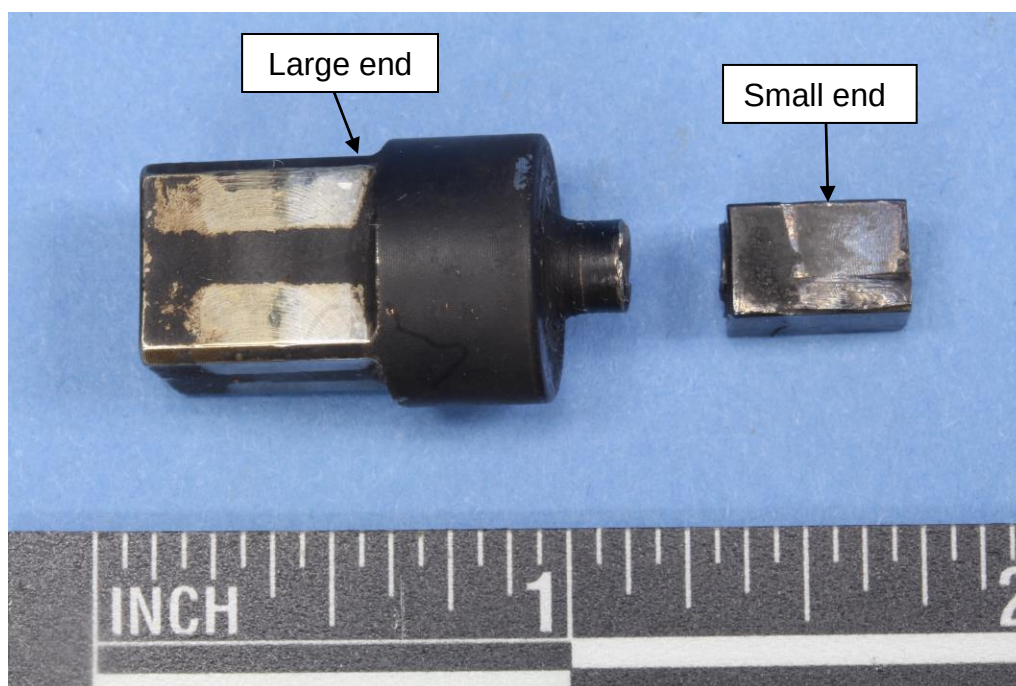


Figure 1. Overall side view of the as-received coupling halves.

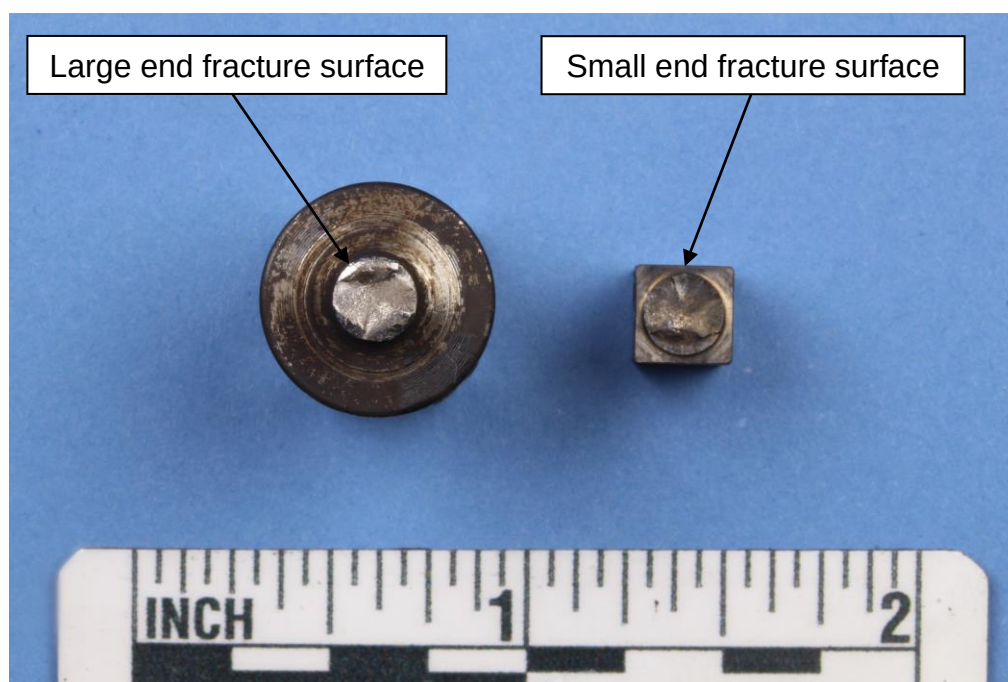


Figure 2. Overall top-down view of the as-received coupling halves.

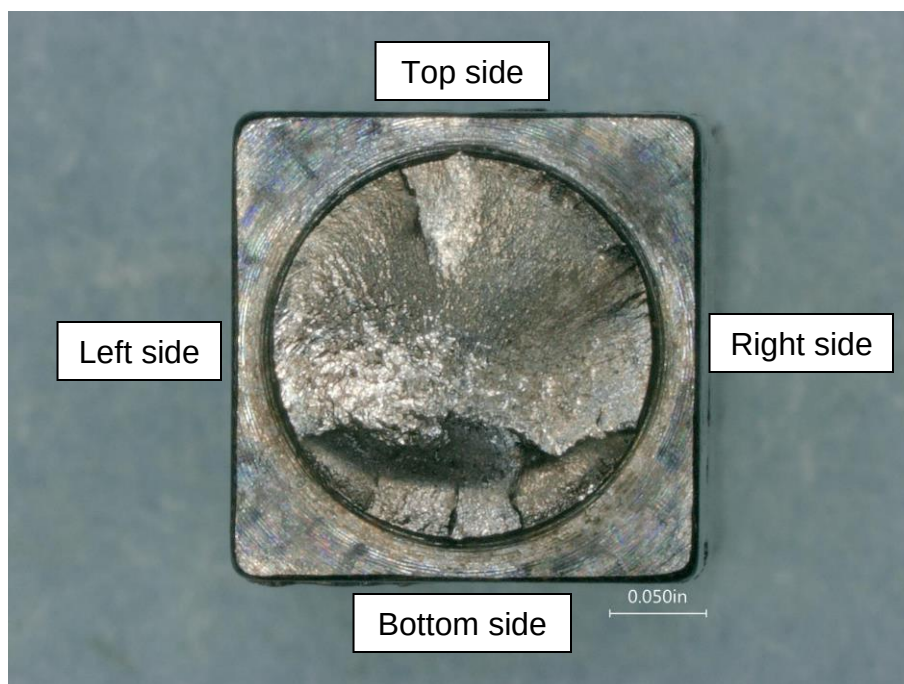


Figure 3. Digital microscope image of the small end fracture surface with the four sides indicated.

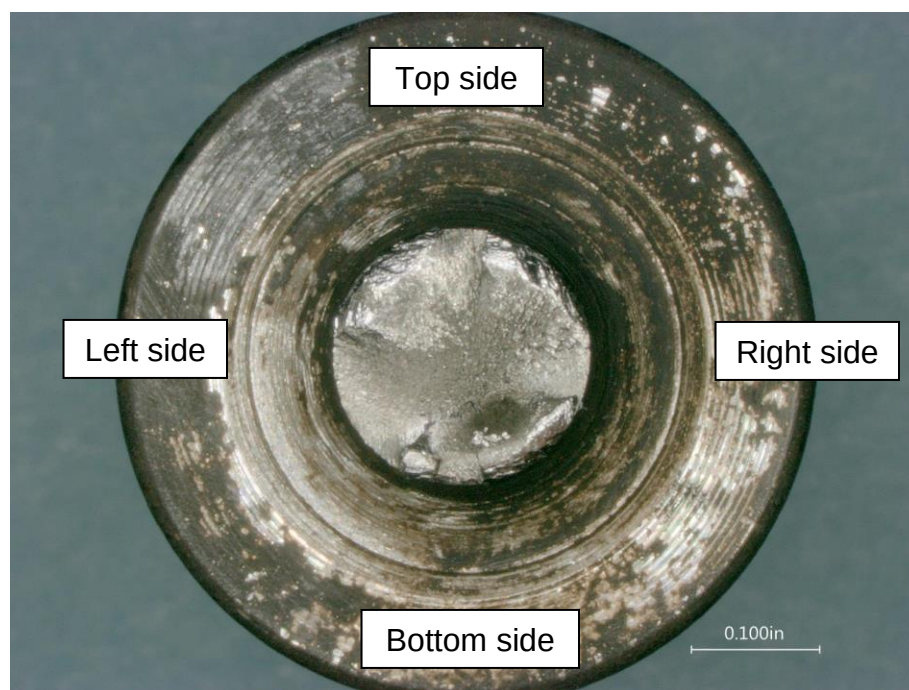


Figure 4. Digital microscope image of the large end fracture surface with the four sides indicated.

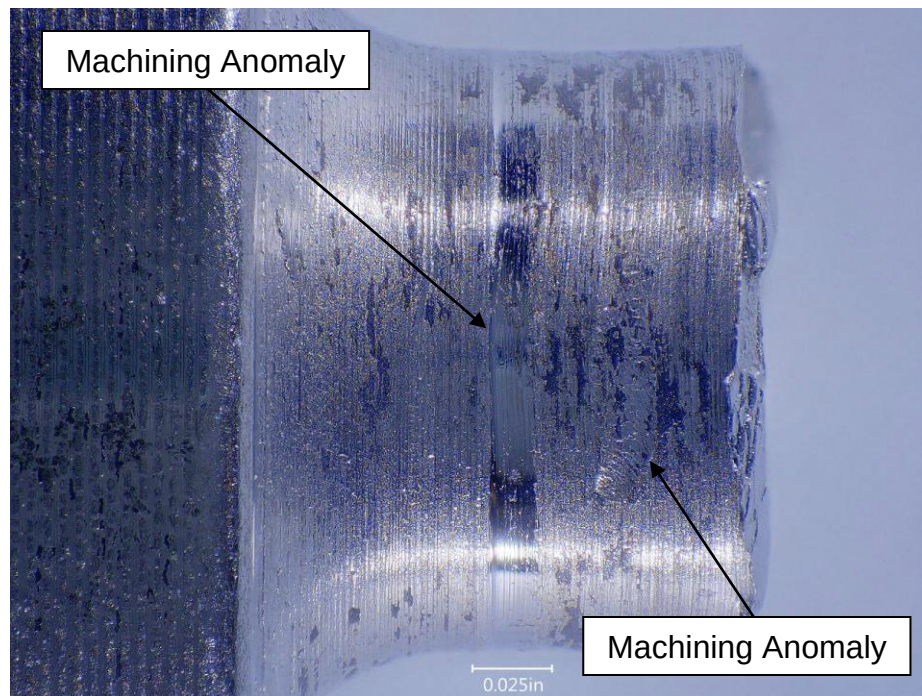


Figure 5. Digital microscope image of the round shear section of the coupling showing anomalies within the machining marks.



Figure 6. Digital microscope image of the bottom side of the large end of the coupling showing wear marks.

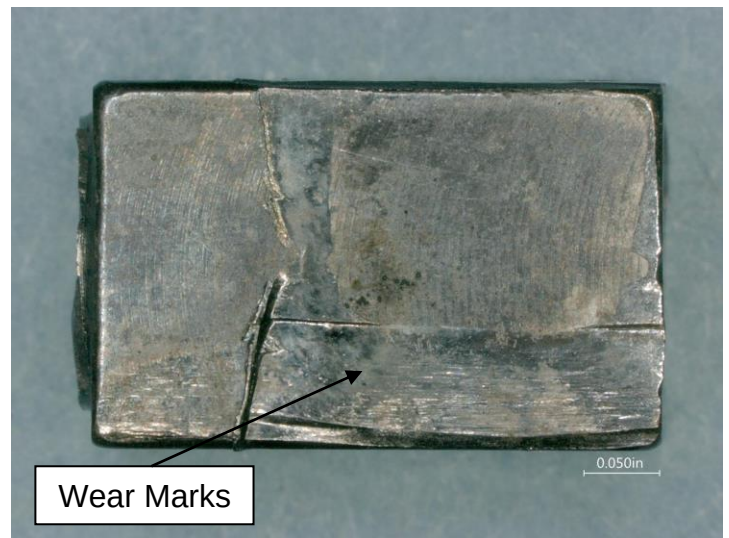


Figure 7. Digital microscope image of the bottom side of the small end of the coupling showing wear marks.

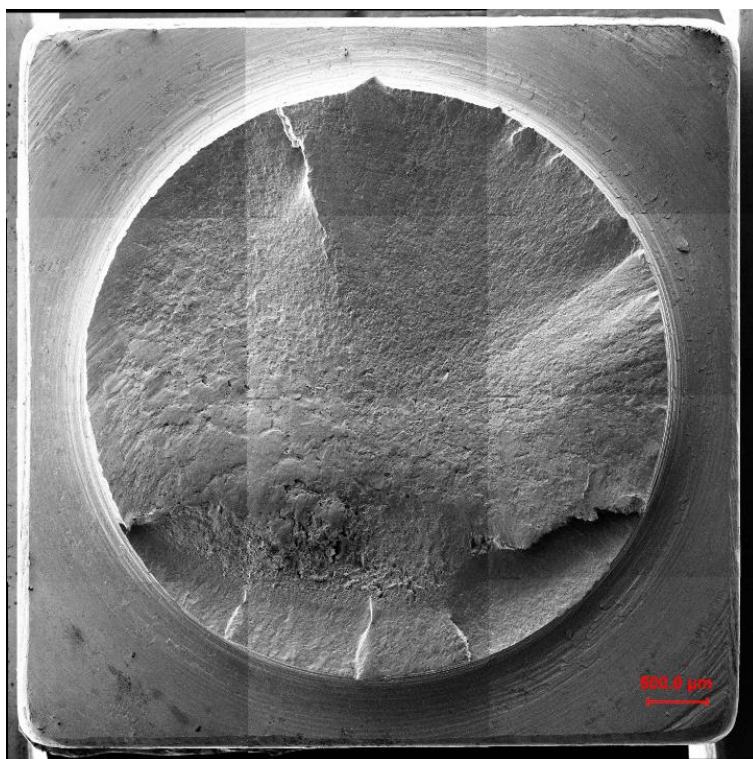


Figure 8. Scanning electron fractograph montage of the small end of the coupling.

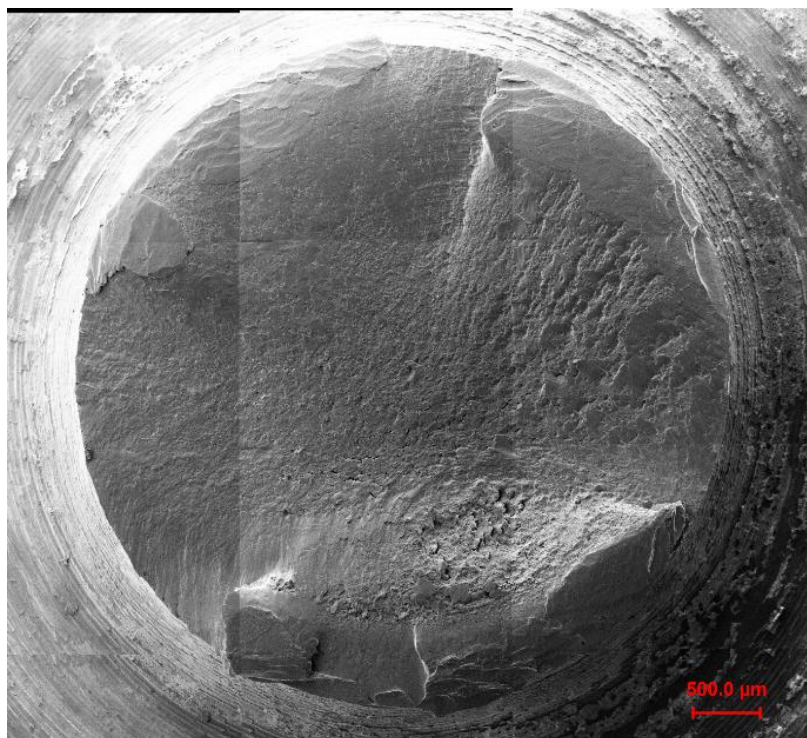


Figure 9. Scanning electron fractograph montage of the large end of the coupling.

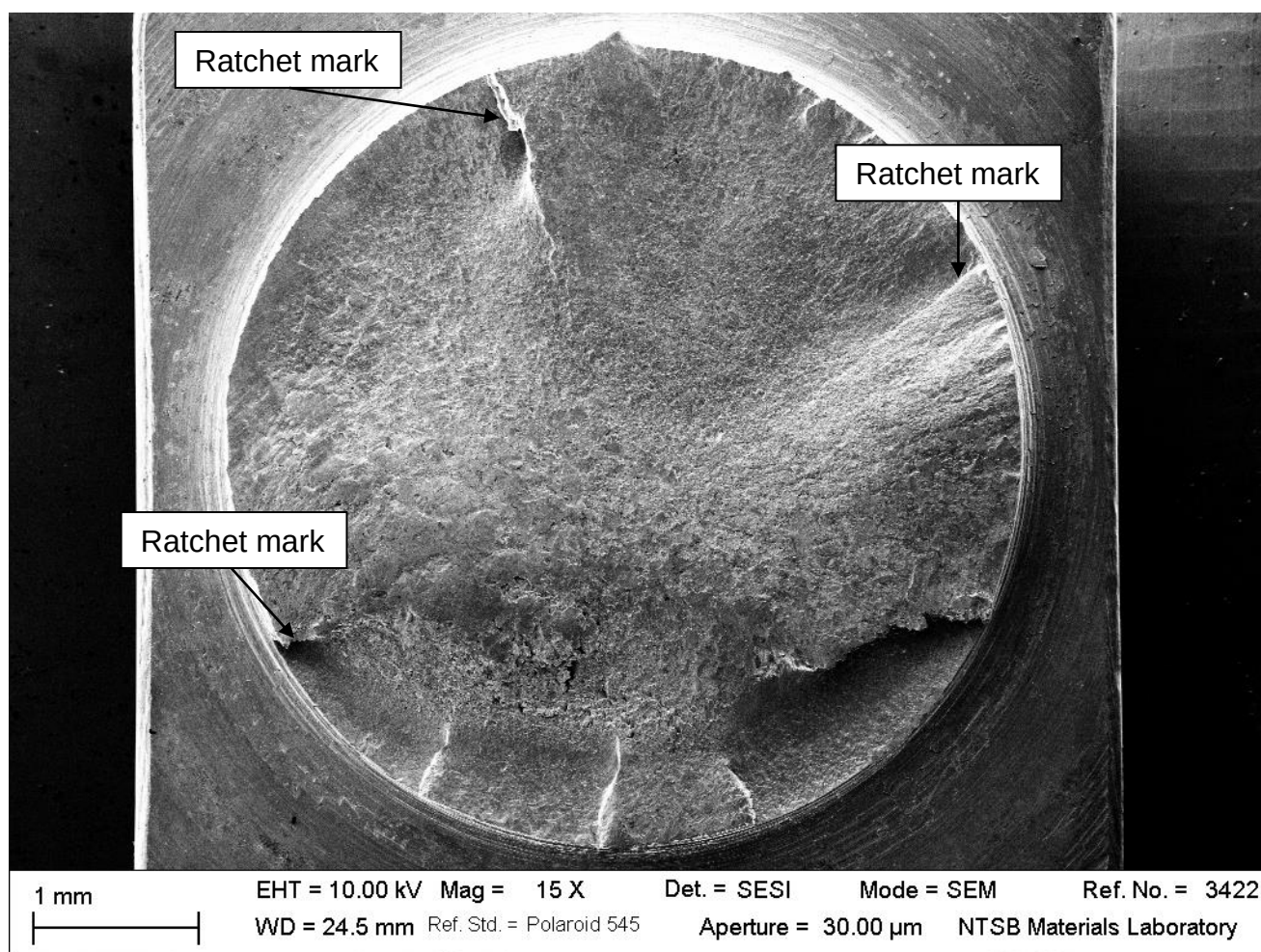


Figure 10. Scanning electron fractography of the small end fracture surface with ratchet marks indicated.

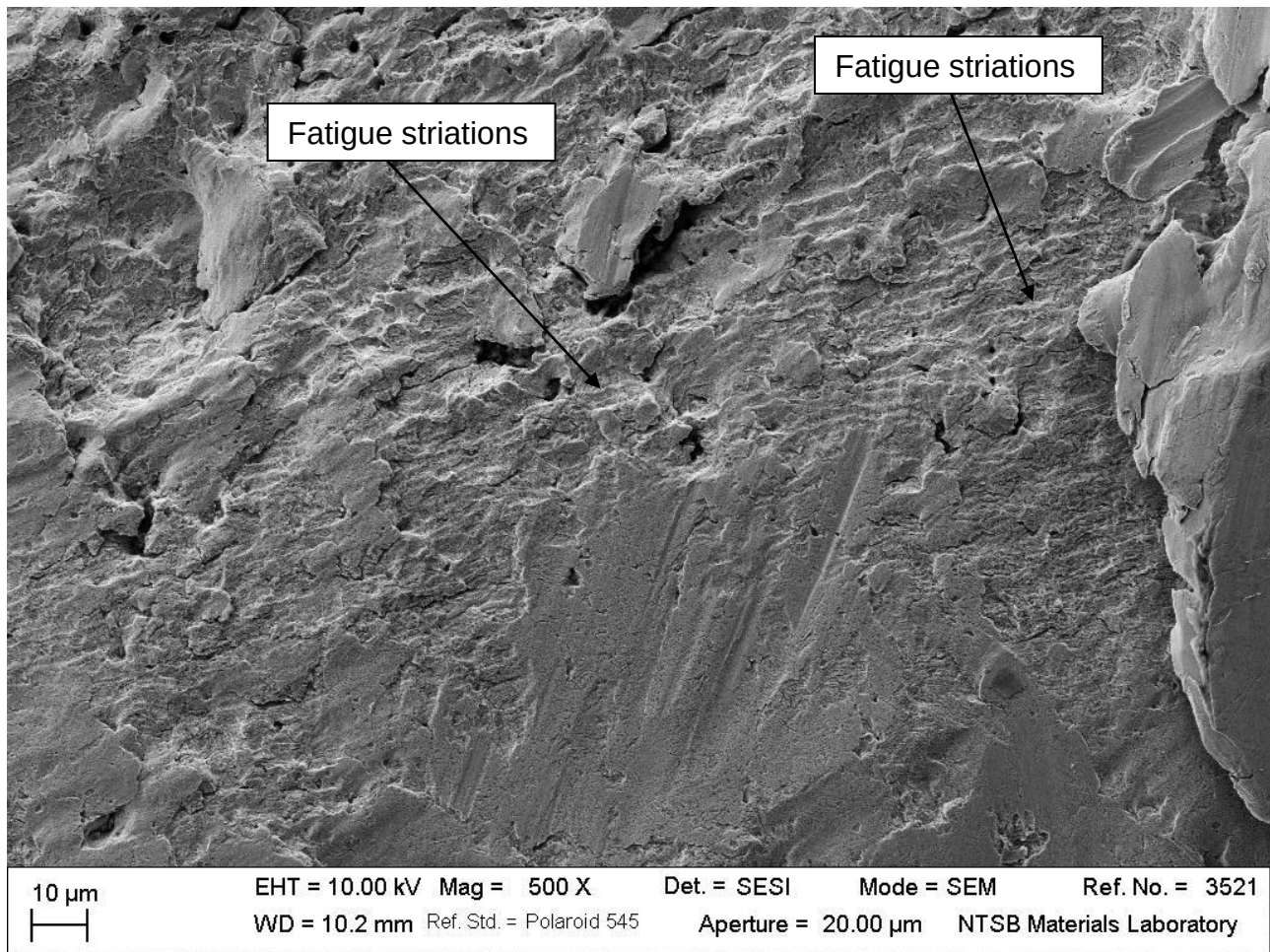
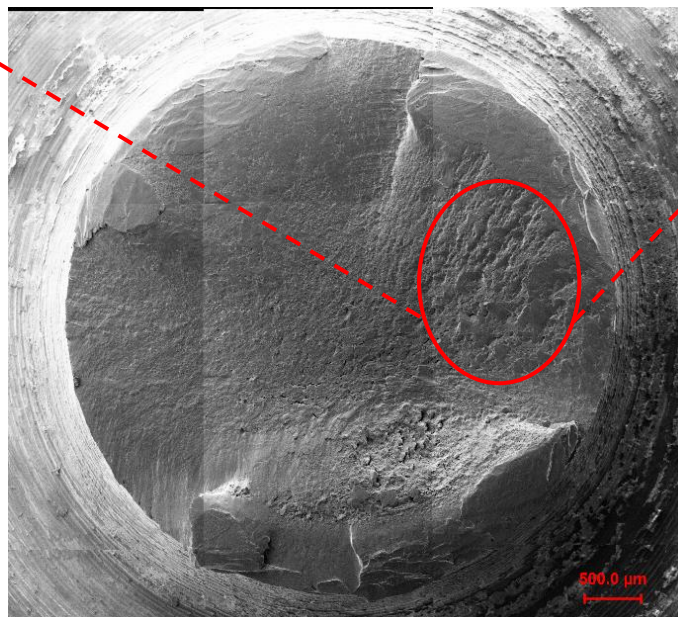


Figure 11. Scanning electron fractograph of the large end fracture surface showing fatigue striations.



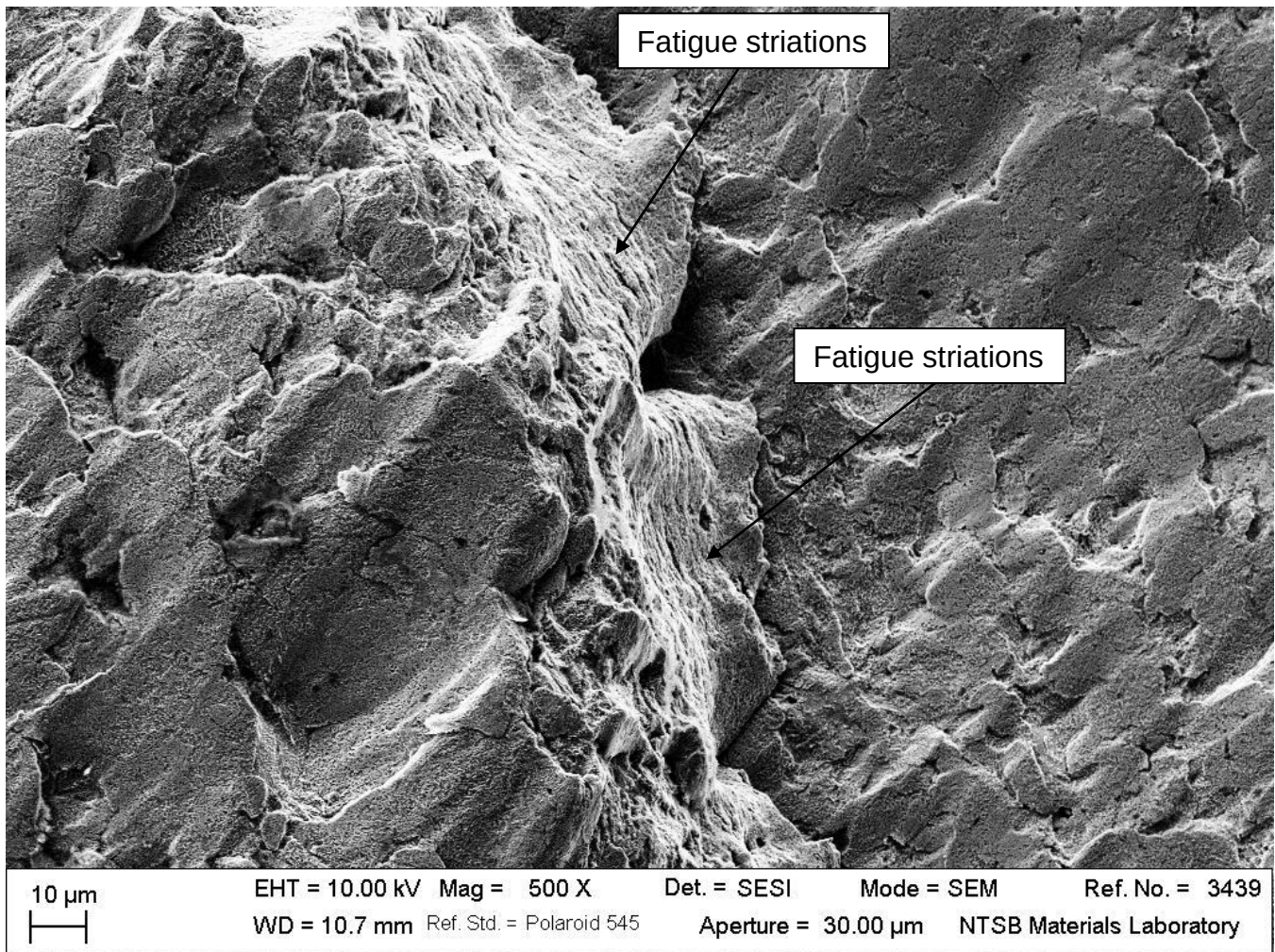
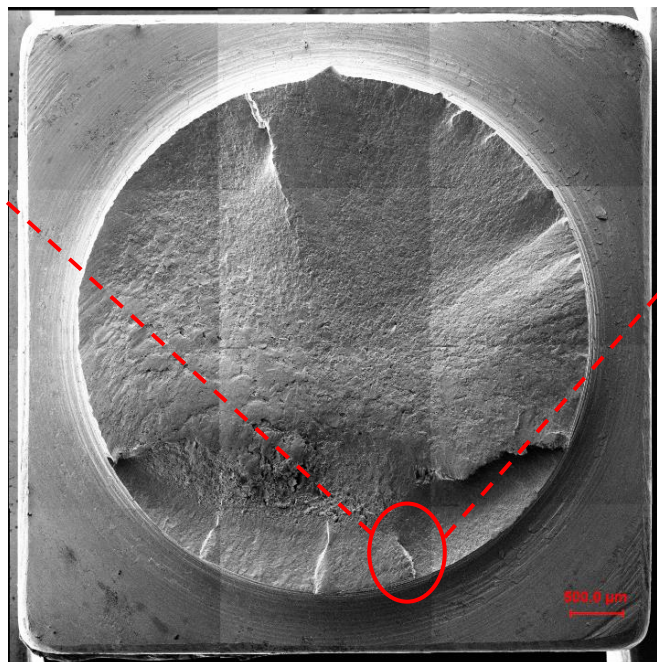


Figure 12. Scanning electron fractograph of the small end fracture surface showing fatigue striations.



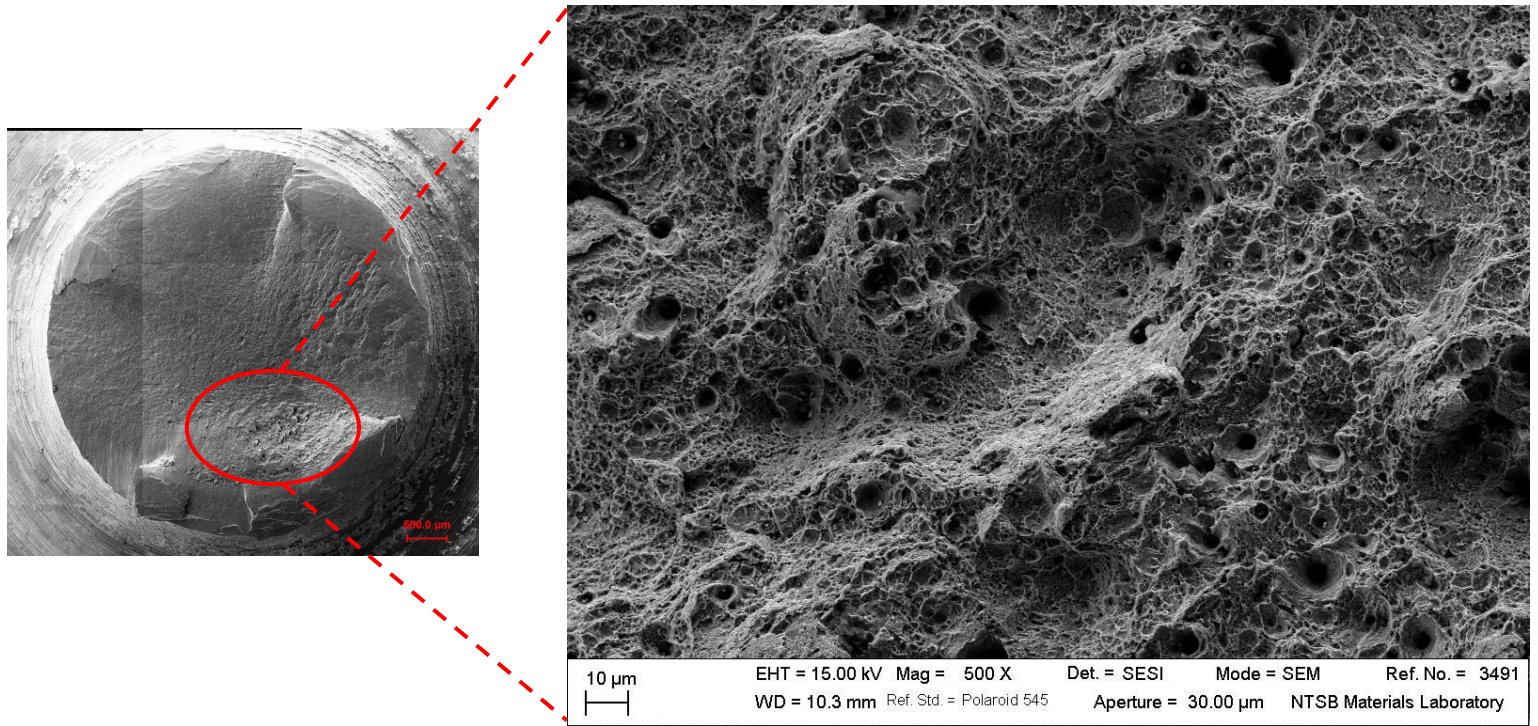


Figure 13. Scanning electron fractograph showing microvoid coalescence present on the large end fracture surface.

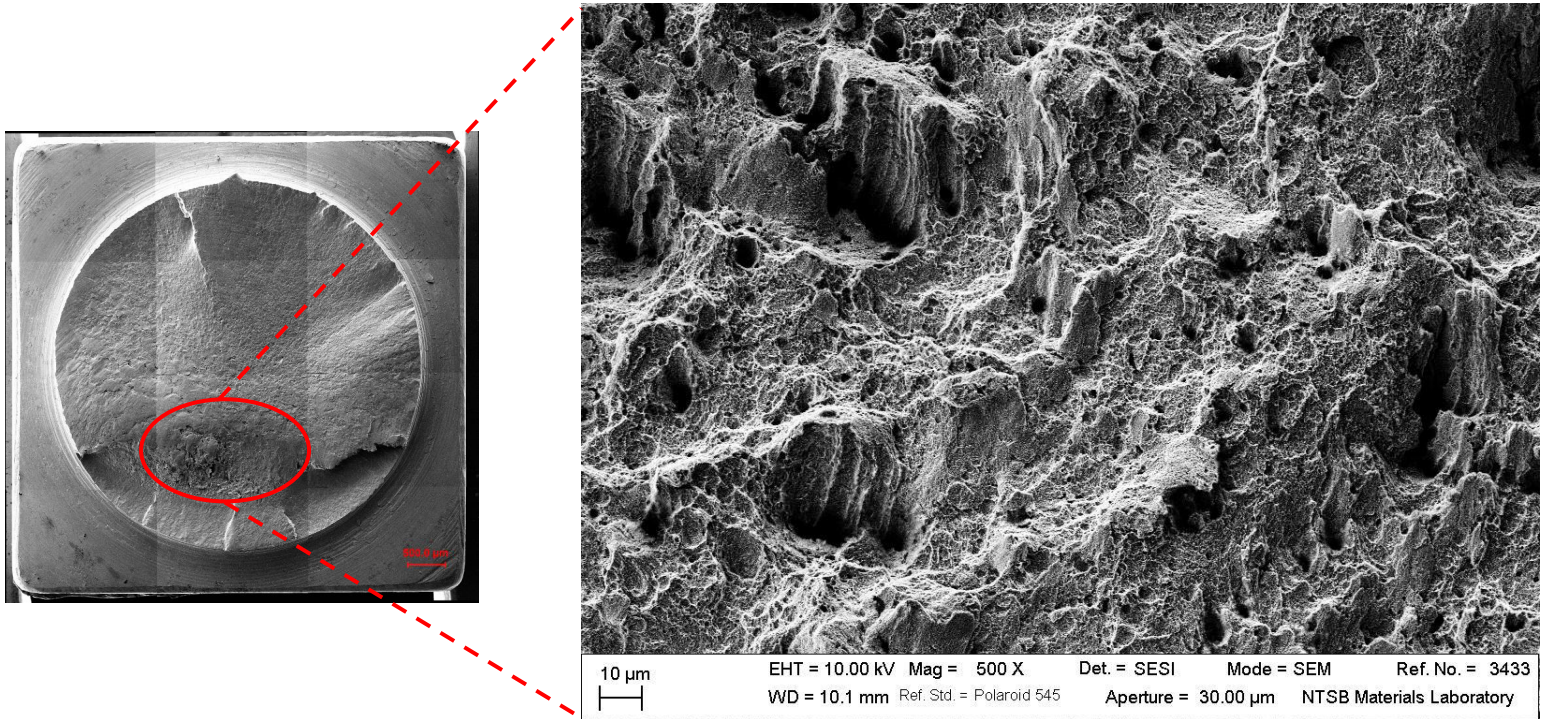


Figure 14. Scanning electron fractograph showing microvoid coalescence present on the small end fracture surface.