

NATIONAL TRANSPORTATION SAFETY BOARD

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



August 21, 2018

MATERIALS LABORATORY FACTUAL REPORT

Report No. 18-069

A. ACCIDENT INFORMATION

Place : Apple Valley, CA
Date : July 22, 2017
Vehicle : Applegate Panzl S331E (N331ST)
NTSB No. : WPR17FA161
Investigator : Samantha Link (AS-WPR)

B. COMPONENTS EXAMINED

Control tube rod ends

C. DETAILS OF THE EXAMINATION

The rod ends of a control tube were submitted sectioned from the main body, as shown in Figure 1. The shaft end of one rod end was separated, while a portion of the outer ring of the other rod end was missing.

The fracture surfaces on the two rod ends were examined using a 5x to 50x digital zoom microscope. Figure 2 shows the separation through the shaft of the first rod end. The separation was through the threaded portion of the rod end shaft. The fracture surface on the shaft was at an approximately 45-degree angle to the longitudinal axis of the shaft. The fracture surface had features consistent with shear overstress.

Figure 3 and Figure 4 show the fracture surfaces through the outer ring on the second rod end. The fracture surfaces were labeled A and B. Both fracture surfaces had relatively flat areas emanating from the inner diameter (ID) of the outer ring. Fracture surface A had smearing damage on much of its flat area. The fracture surfaces transitioned to angular planes adjacent to the outer diameter (OD), which is consistent with shear lips. The fracture surfaces of the separated outer ring were then examined using a Zeiss Auriga field emission (FE) scanning electron microscope (SEM), as shown in Figure 5 – Figure 8. The smearing damage on fracture surface A obscured most of the finer features. Fracture surface B had feathery features visible in the flat area that are consistent with fatigue cracking, as shown in Figure 7. The angular shear lip area had microvoid coalescence consistent with overstress, as shown in Figure 8.

The second rod end was analyzed using a Thermo Scientific Niton XL3t-980 x-ray fluorescence (XRF) alloy analyzer. The results were consistent with a tool steel that had cadmium plating on the external surfaces.

Adrienne V. Lamm
Materials Engineer

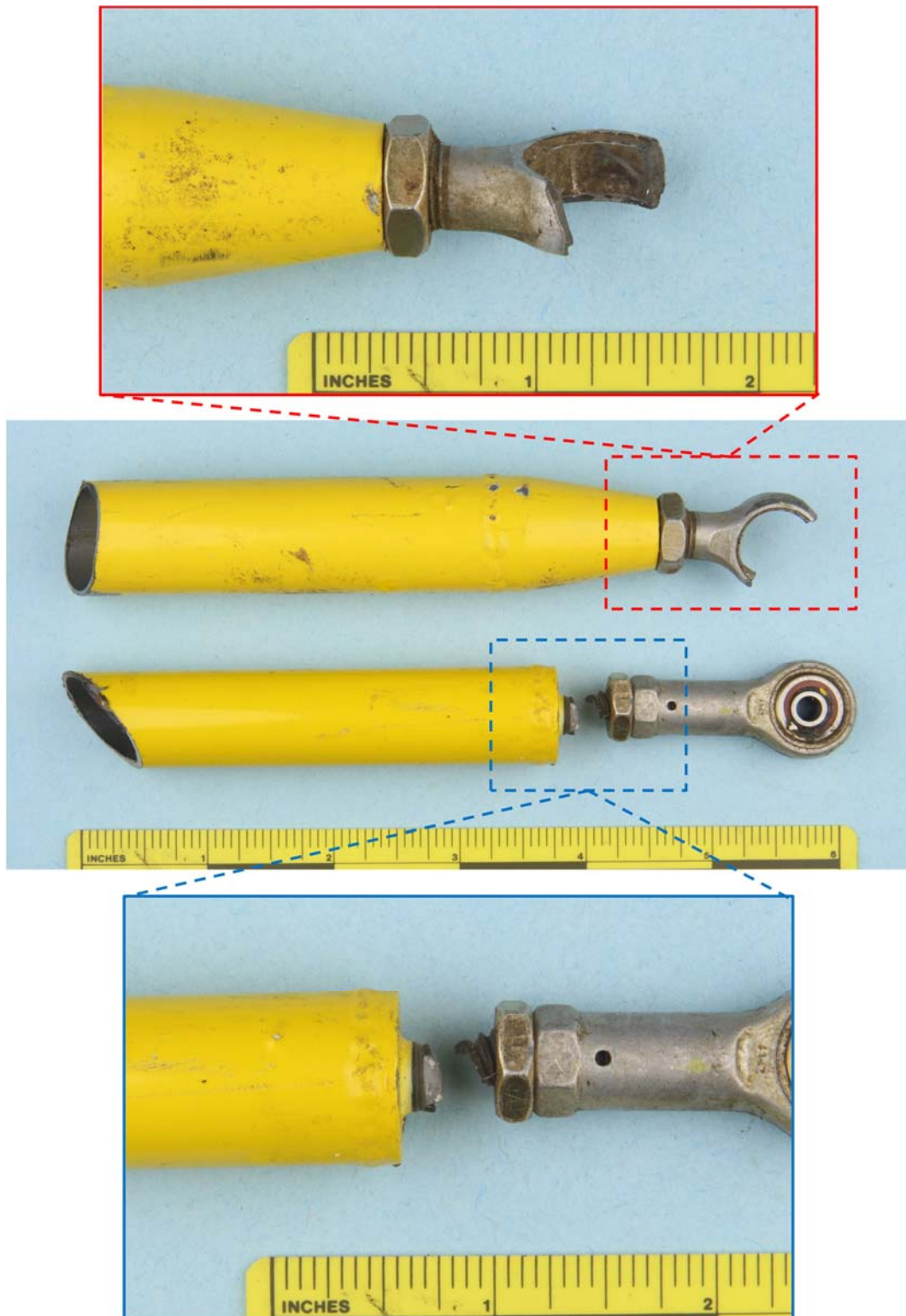


Figure 1: Overall (middle) and close-up (top and bottom) photos of the separations of the rod ends of the control tube.

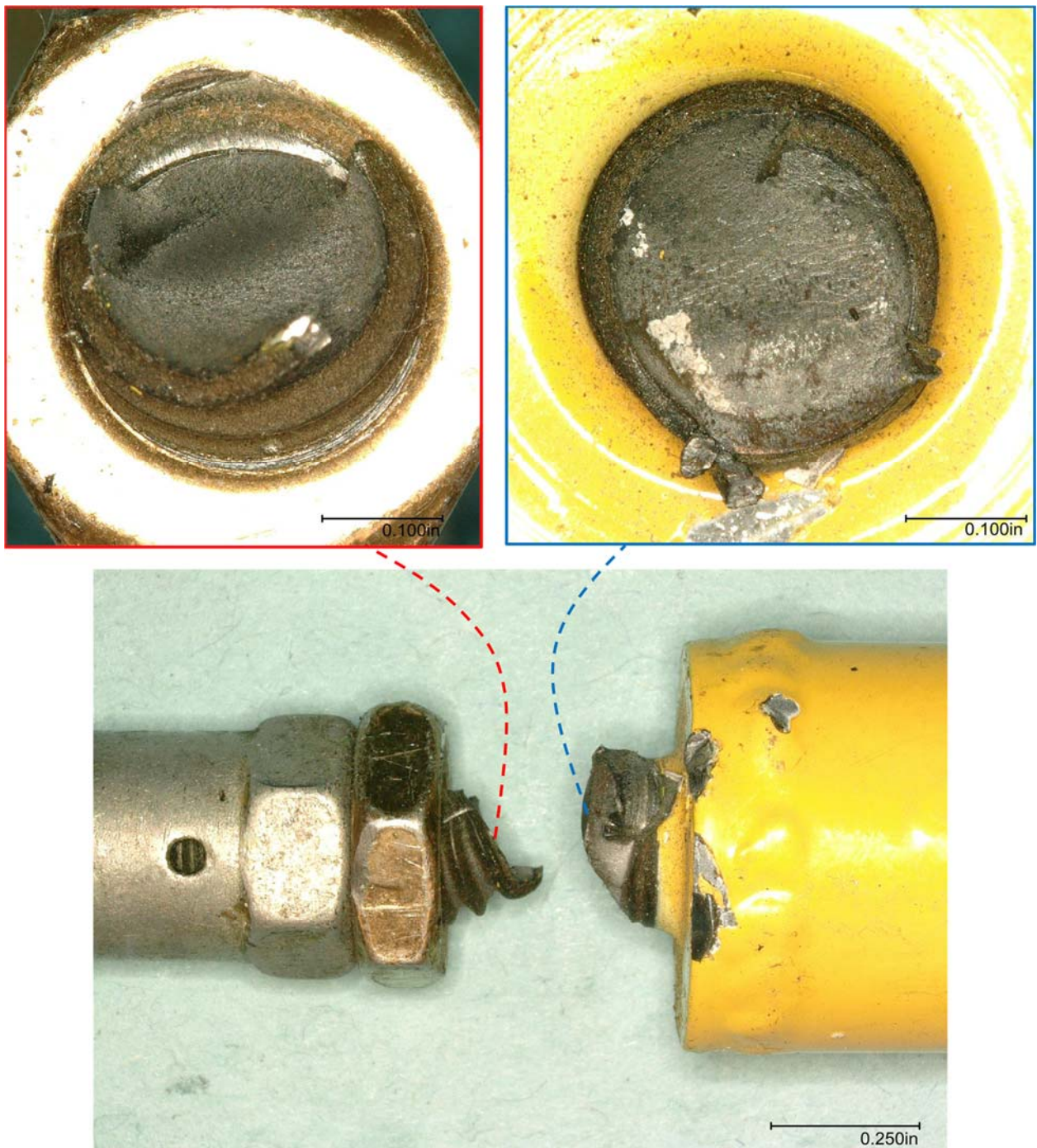


Figure 2: Digital microscope images of the fracture surfaces of the separation through the threaded region of the first rod end.

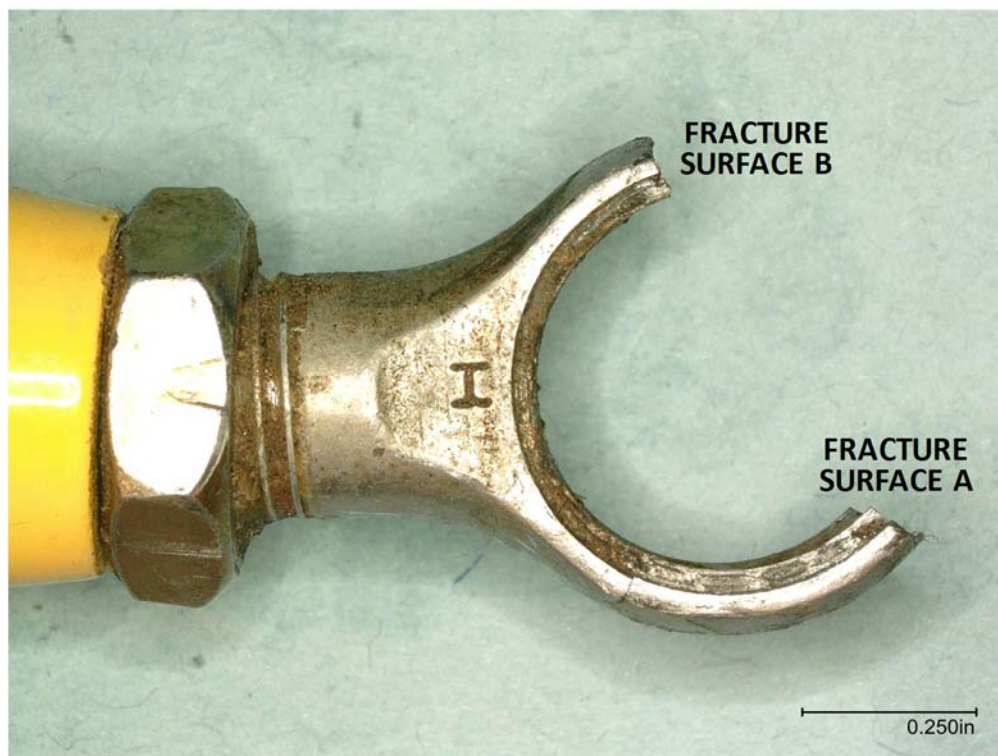
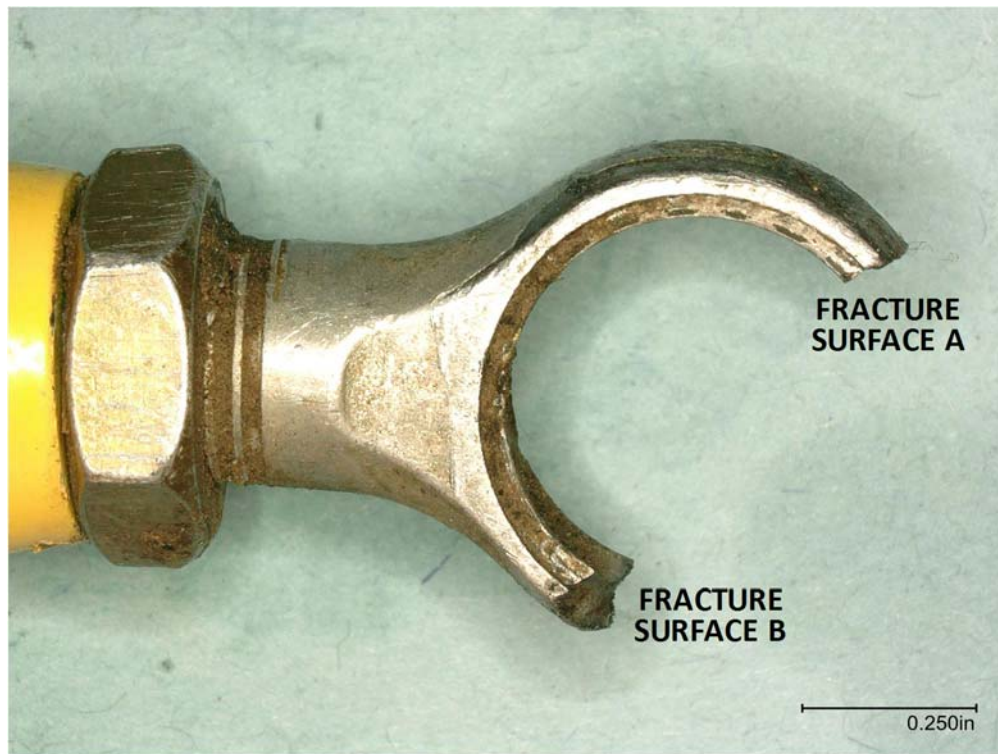


Figure 3: Digital microscope images of the two faces of the second rod end showing the separation through the outer ring.

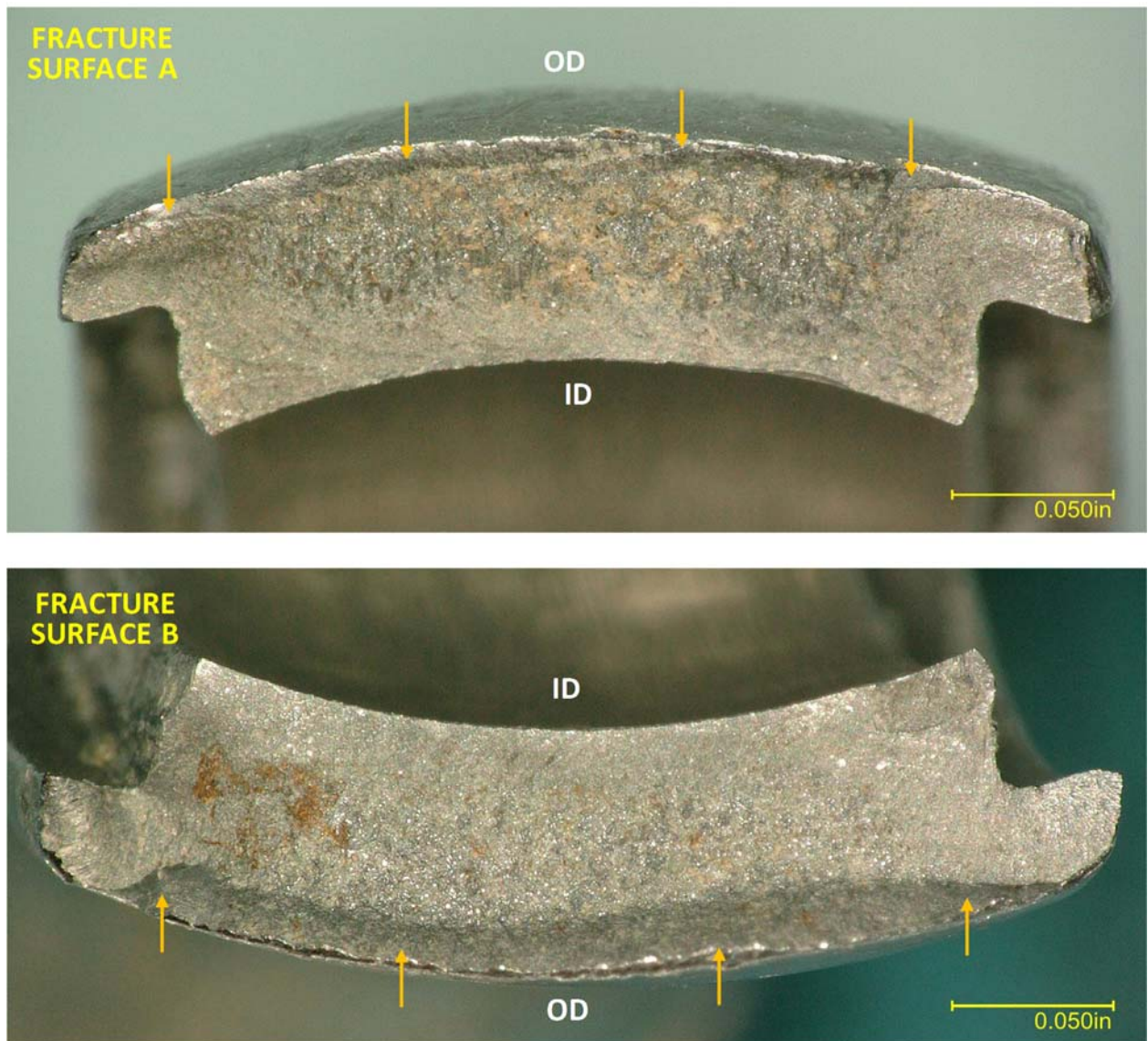


Figure 4: Digital microscope images of the fracture surfaces of the separations through the outer ring of the second rod end. The orange arrows point to the angled shear lips adjacent to the OD of the outer ring.

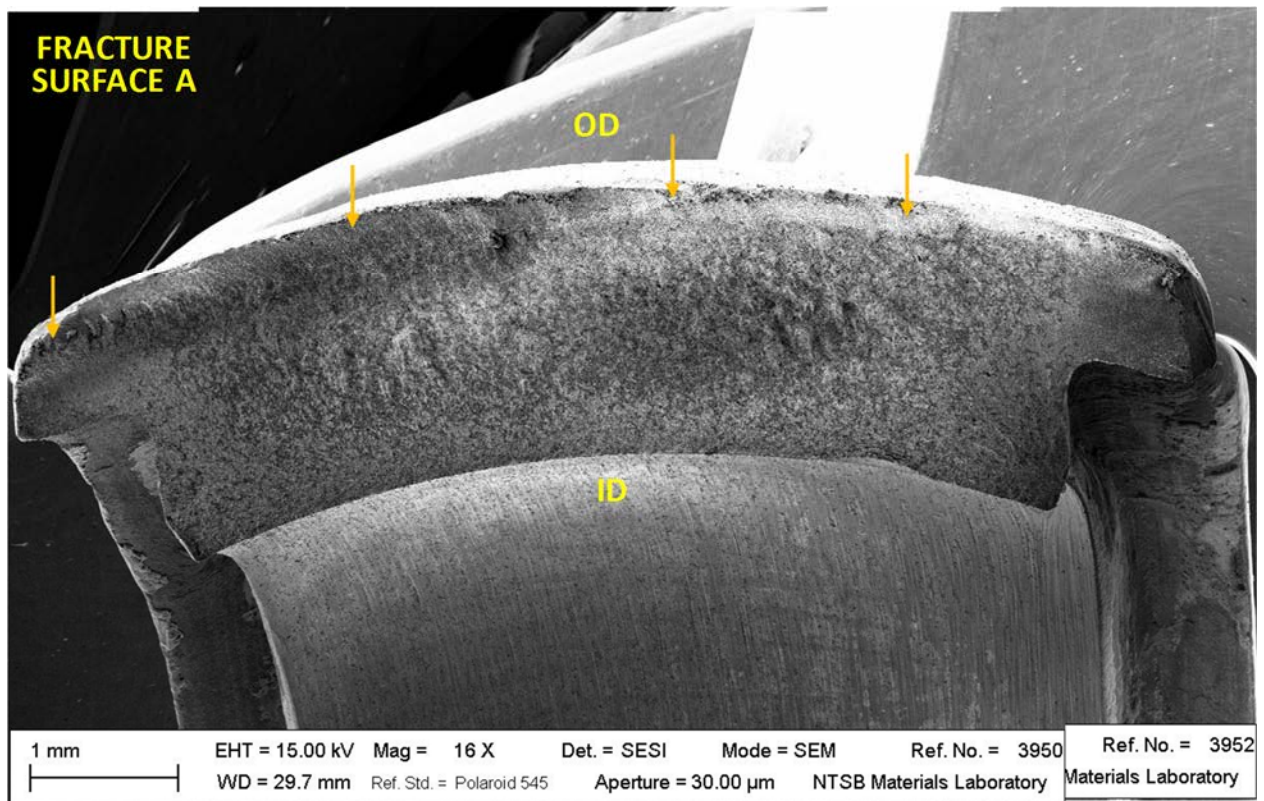


Figure 5: Secondary electron SEM images of fracture surface A on the outer ring of the second rod end. The orange arrows point to the angled shear lip adjacent to the OD of the outer ring.

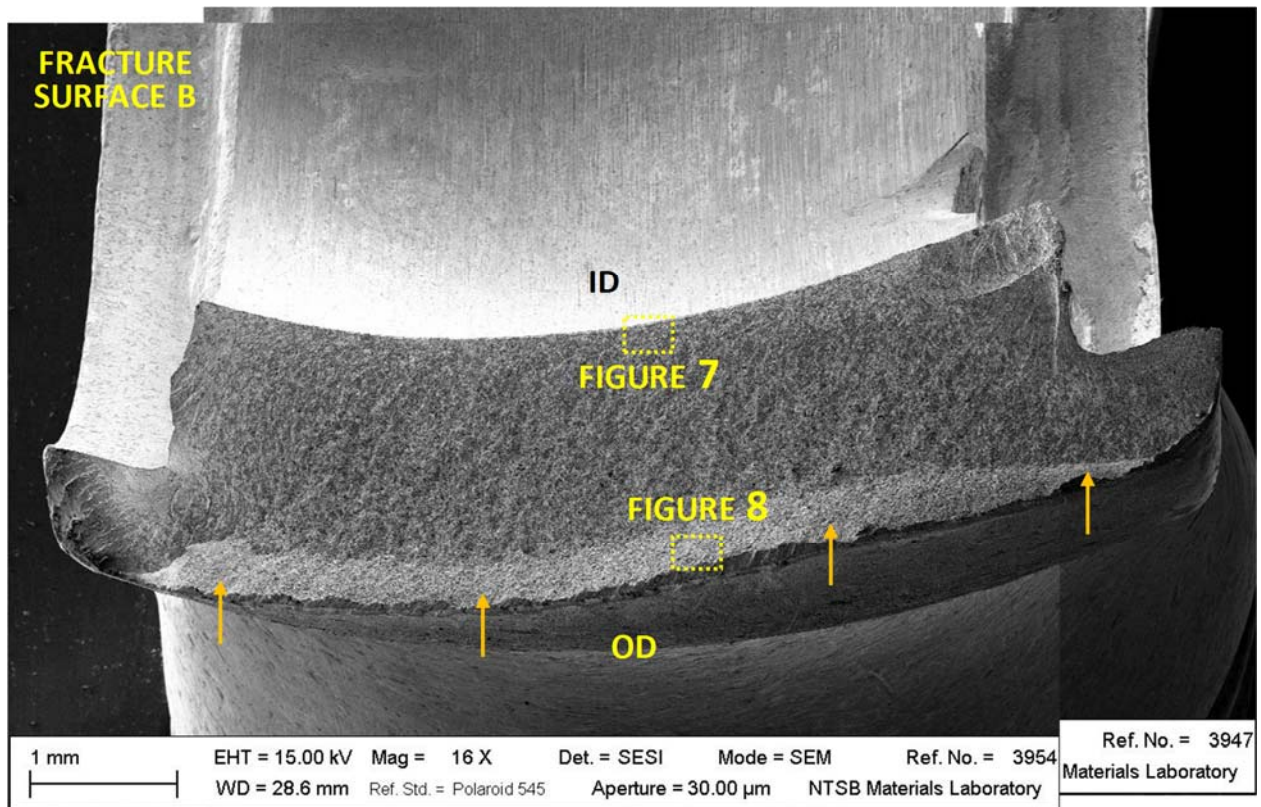


Figure 6: Secondary electron SEM images of fracture surface B on the outer ring of the second rod end. The orange arrows point to the angled shear lip adjacent to the OD of the outer ring.

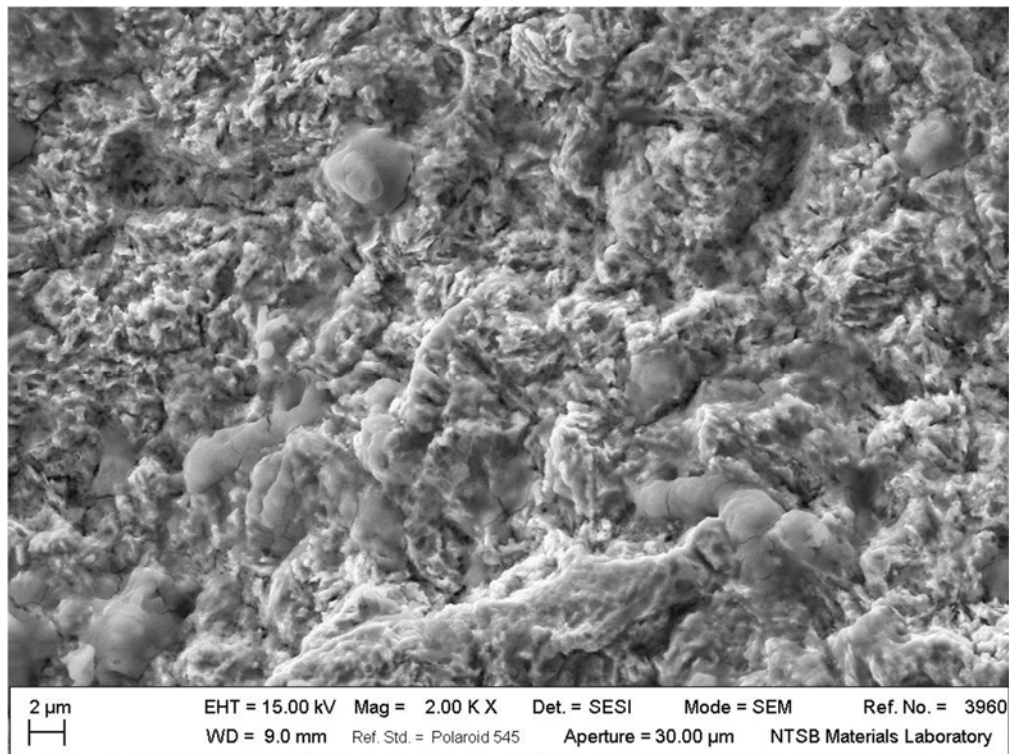
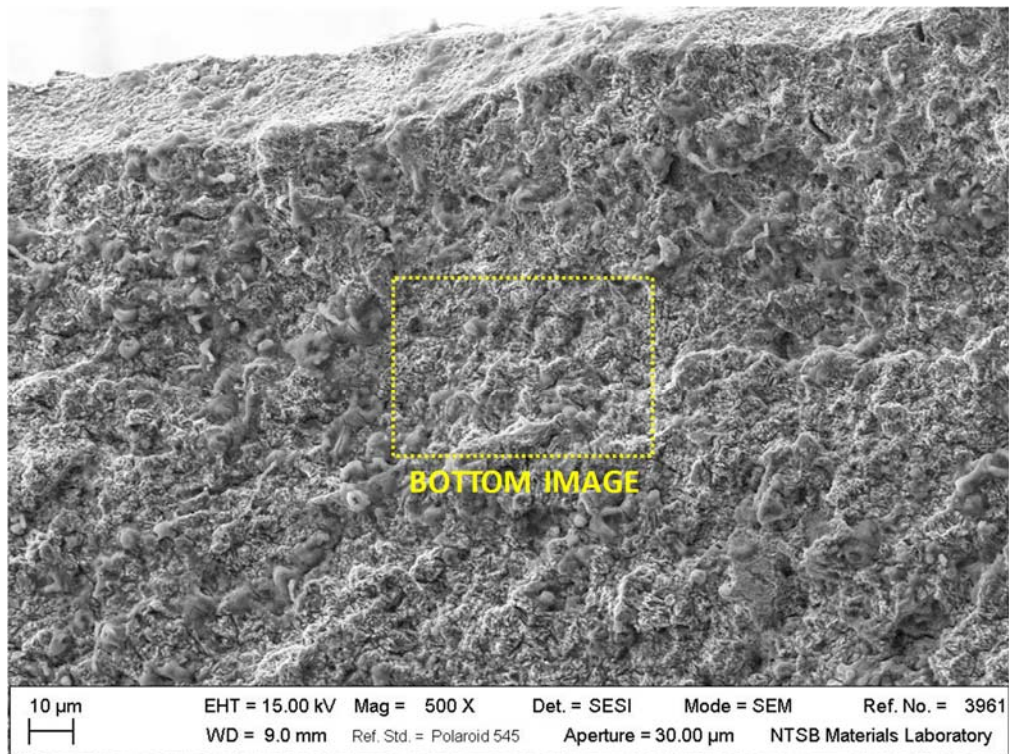


Figure 7: Secondary electron SEM images of the flat area on fracture surface B.

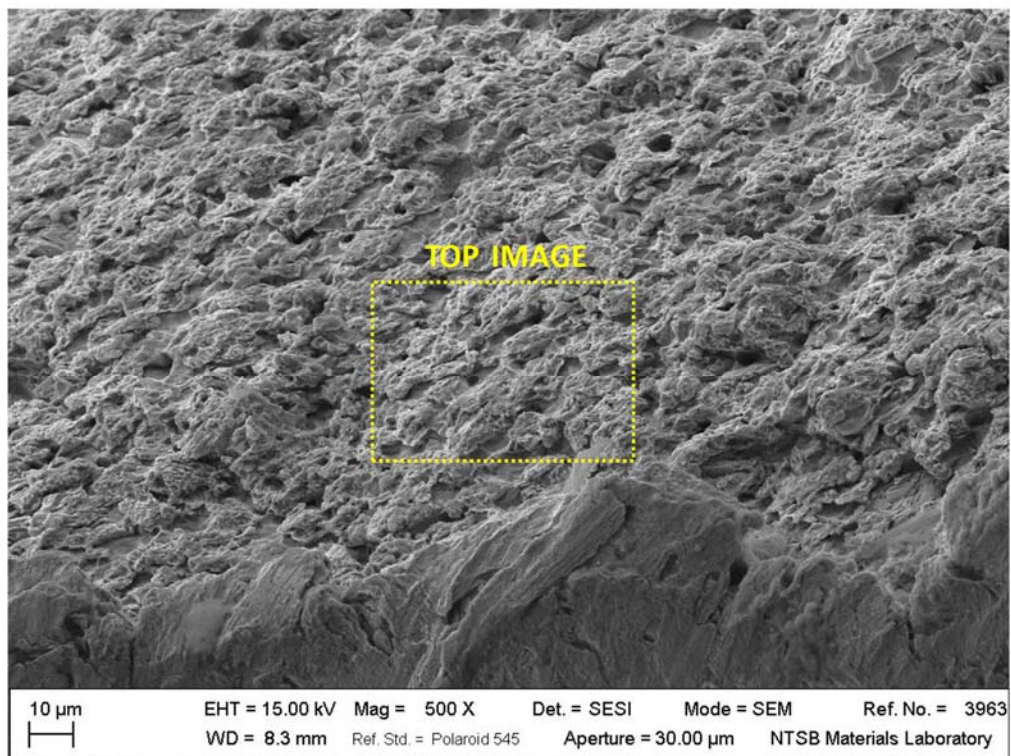
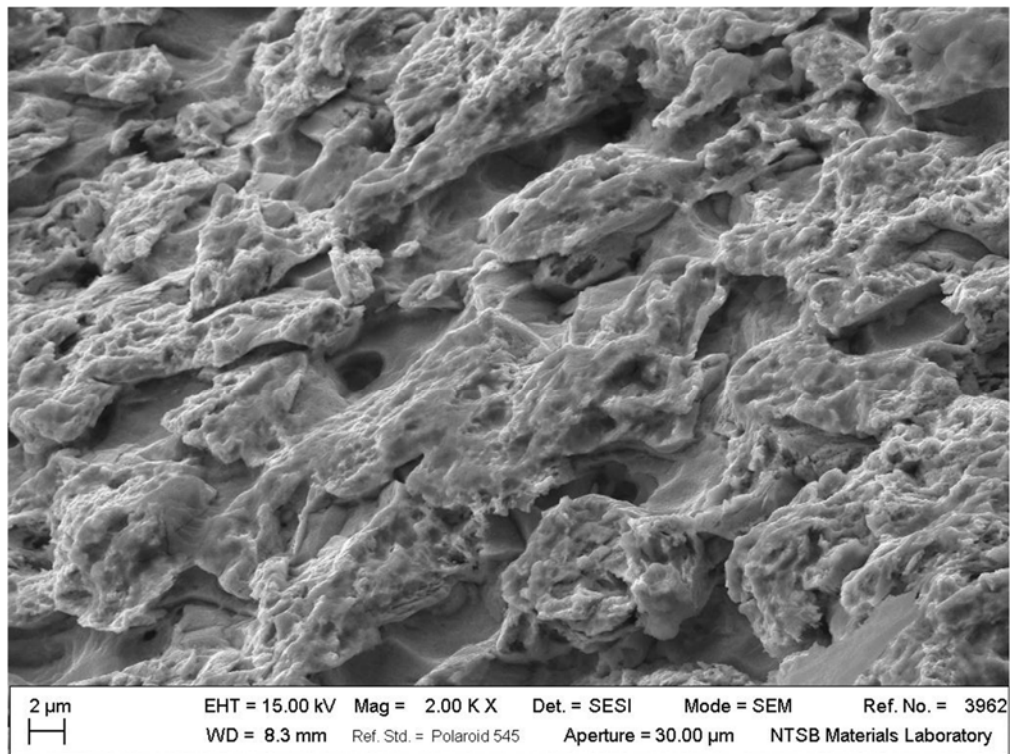


Figure 8: Secondary electron SEM images of the shear lip on fracture surface B.