

National Transportation Safety Board

Office of Research and Engineering

Washington, DC 20594



CEN23FA352

MATERIALS LABORATORY

Factual Report 24-014

March 20, 2024

(This page intentionally left blank)

A. ACCIDENT INFORMATION

Location: Caddo Mills, Texas
Date: August 7, 2023
Vehicle: Cessna 150, N5610E
Investigator: John Brannen (AS-CEN)

B. COMPONENTS EXAMINED

Crankshaft gear and bolts

C. EXAMINATION PARTICIPANTS

Specialist Adrienne Lamm
National Transportation Safety Board
Washington, D.C.

D. DETAILS OF THE EXAMINATION

The subject aircraft was consumed by a post-crash fire after impacting the ground on airport property near the departure end of a runway. During post-accident inspection the propeller could only be partially rotated, though it was enough to determine all pistons moved within their cylinders and thus confirmed crankshaft continuity. However, during the partial propeller rotation the rear crankshaft gear was observed not rotating. Subsequent teardown of the engine revealed the crankshaft gear dowel pin and 4 attachment bolts were separated, and only half of each piece was found. The crankshaft gear, dowel pin piece, and 4 bolts pieces were submitted to the NTSB Materials Laboratory for examination.

The dowel pin was still assembled inside the crankshaft gear, as indicated by the red arrows in Figure 1. Figure 2 shows a close-up of the fracture surface on the dowel pin. Macro features on the fracture surface were consistent with shear overstress. The dowel pin sheared from circumferential motion of the gear, indicated by the black dotted line. White arrows point to circumferential scrape marks on the surface of the gear surrounding the dowel pin.

The through holes in the crankshaft gear to which the attaching bolts mated appeared off-center within their respective flanges, as illustrated by the yellow crosshairs in Figure 3. Raised material was observed on one side of each through hole, likely from contact with the mating attachment bolts. One corner was worn on the inboard side of each tooth on the larger diameter gear, as indicated by the black arrows in Figure 4.

The four separated attachment bolts are shown in Figure 5. All the bolts separated in the threaded region, with three bolts separated at the third thread and one bolt separated at the second thread. Locking wire still connected the heads of the bolts into two pairs. The bolts were labeled A, B, C, and D in the lab for identifying purposes.

The fracture surfaces of the bolts in the as-received condition are shown in Figure 6. The fracture surfaces were relatively flat, with those on bolts A, C, and D were covered in thick black deposits consistent with burned oil and debris likely from the post-crash fire. Areas without black deposits had flattening from secondary contact after fracture.

The locking wire was removed and the bolts were iteratively cleaned with mild detergent and a soft bristle brush, followed by an ultrasonic bath of isopropanol, and then soaked in Evapo-Rust® (CRC Industries, Horsham PA) heavy duty rust remover for several hours and rinsed with methanol. Large areas of the fracture surfaces were still covered in the black deposits even after extensive cleaning. The appearance of the fracture surfaces after cleaning are shown in Figure 7. The cleaned fracture surfaces were examined using a scanning electron microscope (SEM). Areas without the black deposits were covered in heavy oxidation products from the post-crash fire.

A more aggressive cleaning was attempted on bolt C, which was the bolt with the most promising areas of possible fracture features. Bolt C was soaked in Evapo-Rust® for 8 hours, with periodic removal for surface scrubbing with a soft bristle brush and methanol rinse. The appearance of the fracture surface on bolt C after the more aggressive cleaning is shown in Figure 8. Bolt C was again examined using a SEM, with resulting images shown in Figures 9 and 10. The areas free of black deposits remained heavily oxidized that completely obscured any finer features.

Consequently, the exact fracture mechanism of the bolts could not be determined.

Submitted by:

Adrienne V. Lamm
Materials Engineer



Figure 1. Macro photos of the submitted crankshaft gear and attachment bolts. The red arrows points to the dowel pin still assembled inside the gear.

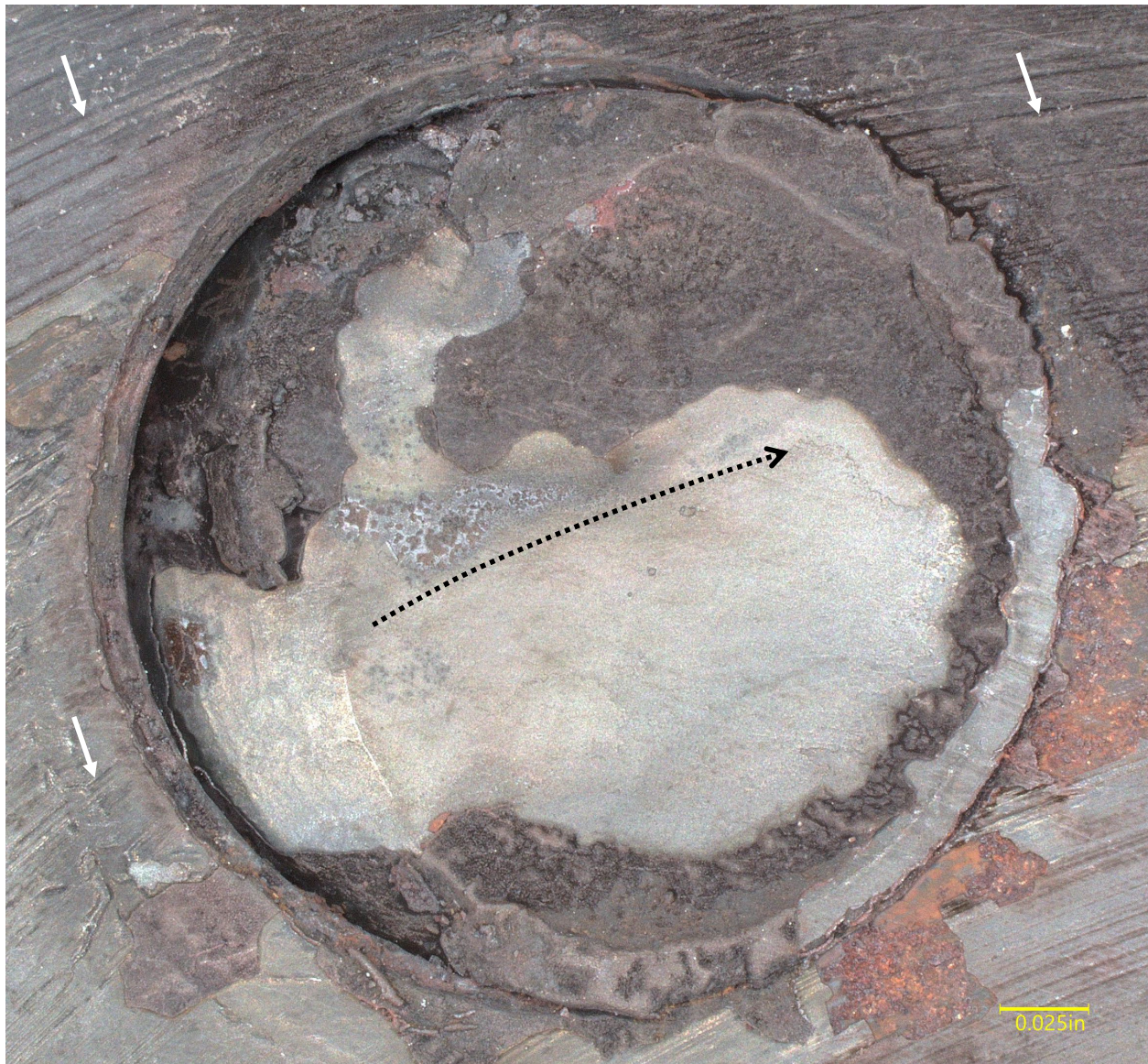


Figure 2. Close-up photo of the fracture surface on the dowel pin. The black dotted arrow indicates the direction of shear the fractured the dowel pin. The white arrows point to circumferential scrape marks on the surface of the gear surrounding the dowel pin.

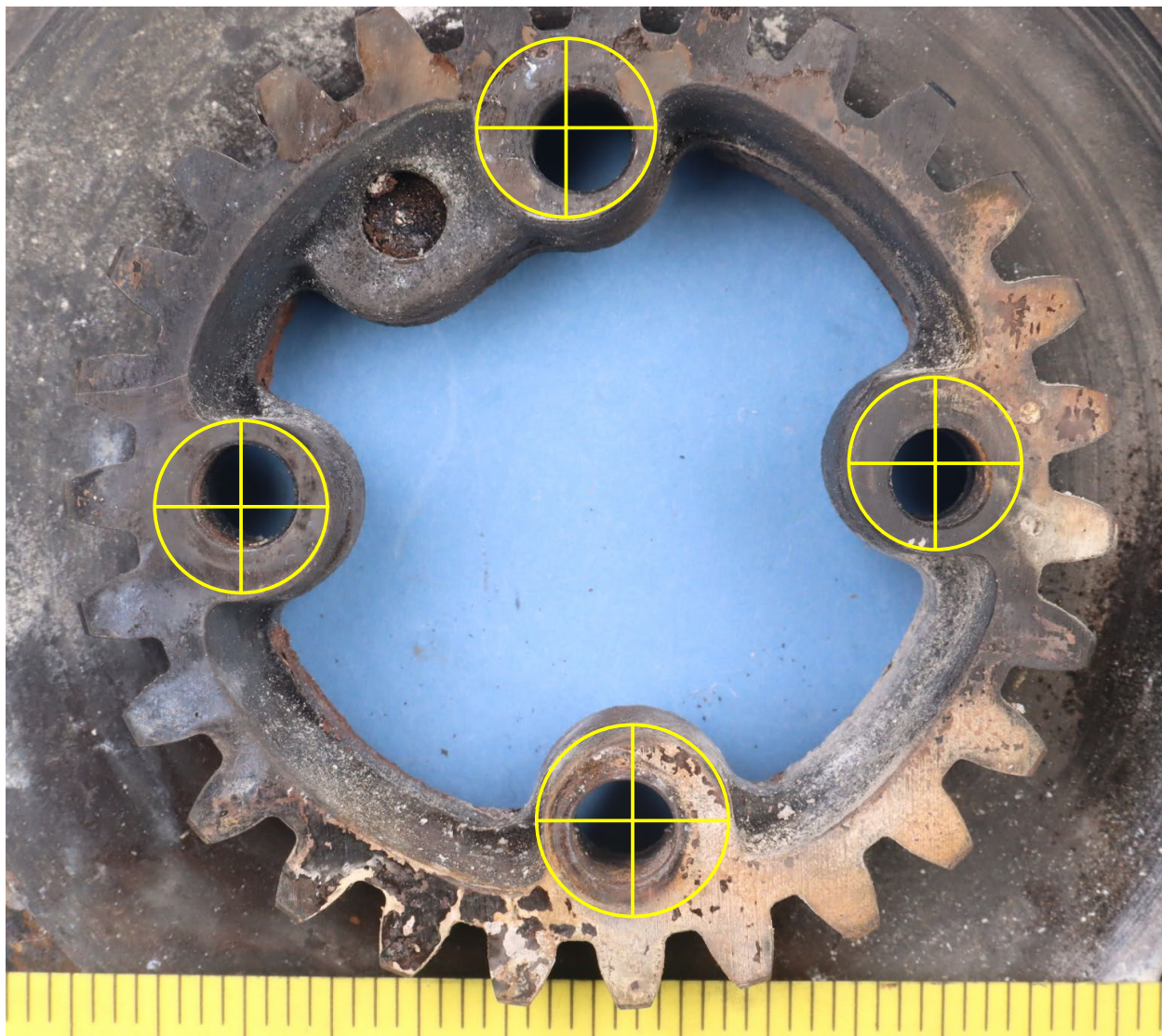


Figure 3. Close-up photo showing the through holes in the crankshaft gear, with yellow crosshairs illustrating their positions relative to their respective flanges.

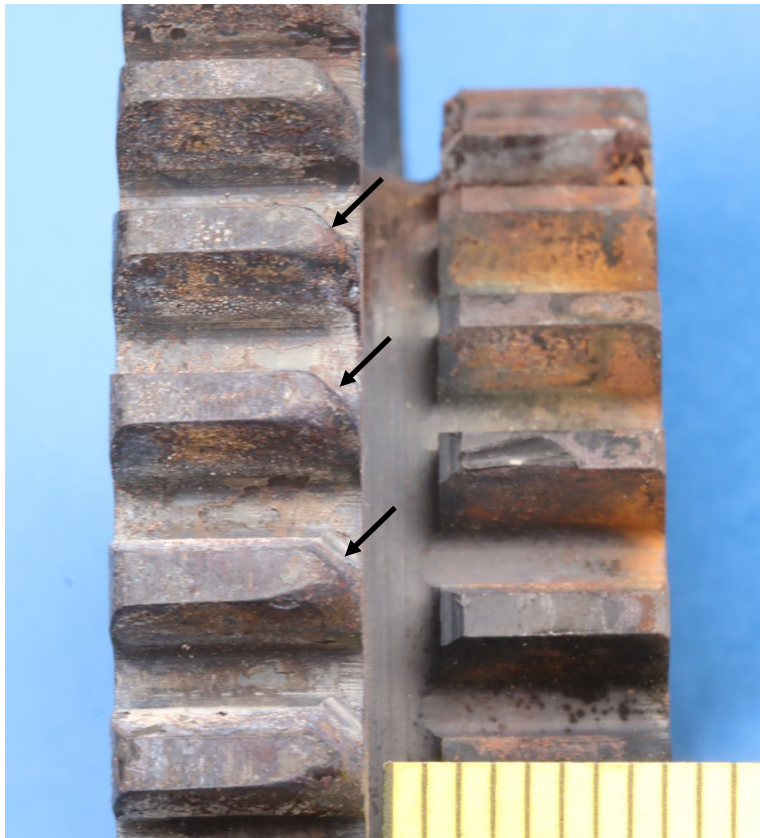
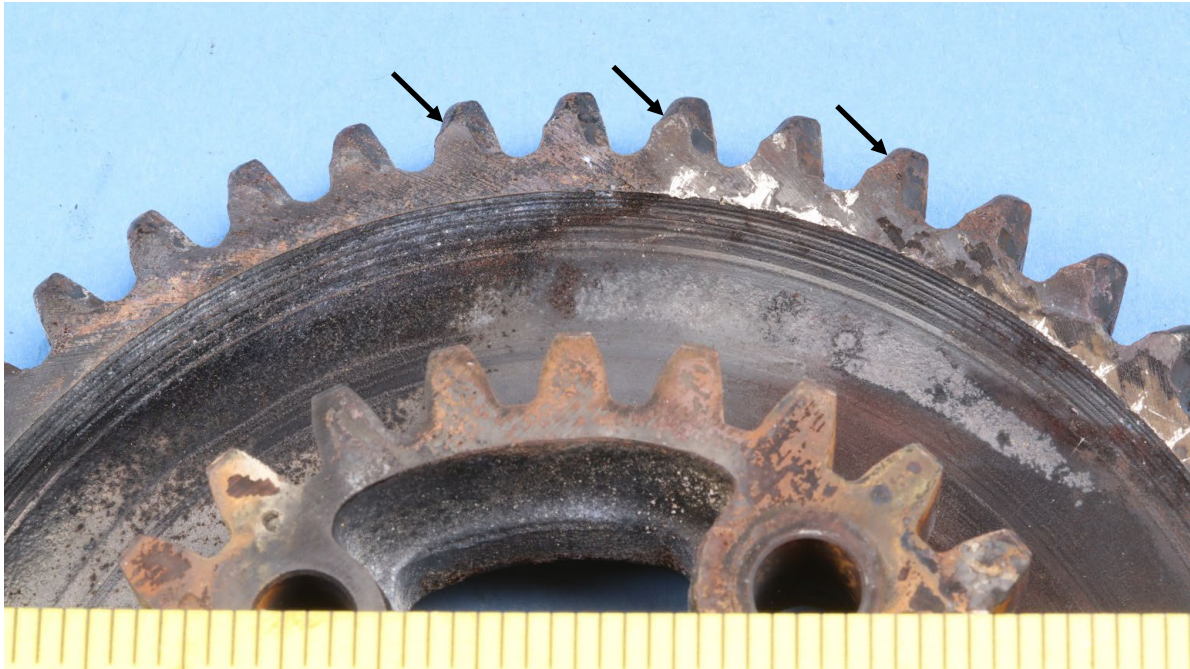


Figure 4. Close-up photos of the teeth on the crankshaft gear. The black arrows point to wear on one inboard corner of each tooth on the larger diameter gear.



Figure 5. Macro photo of the fractured attachment bolts.

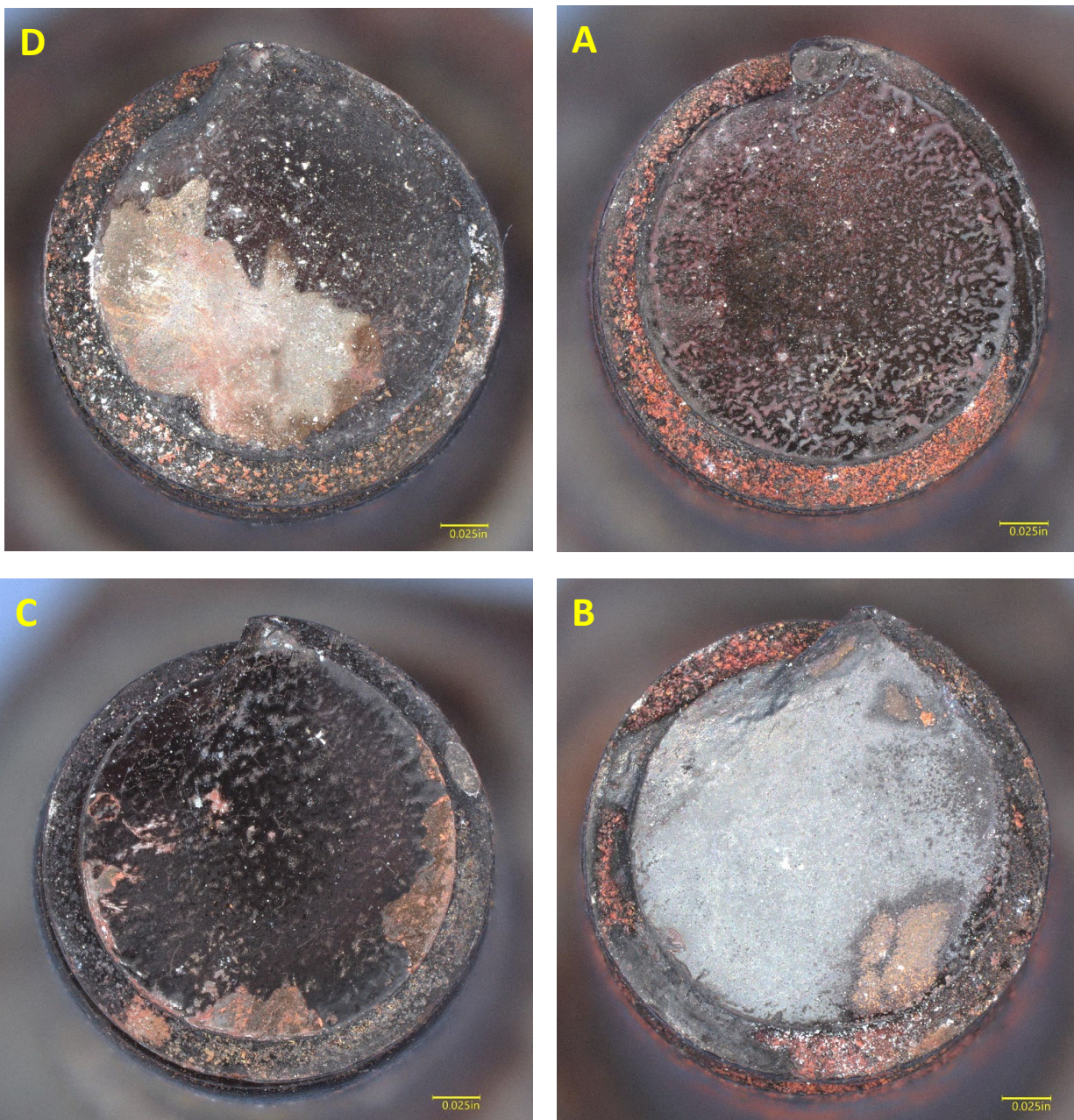


Figure 6. Digital microscope images of the fracture surfaces on the attachment bolts in the as-received condition.

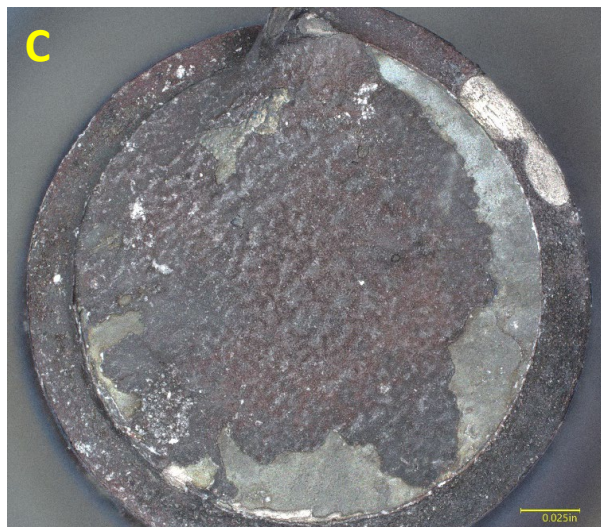
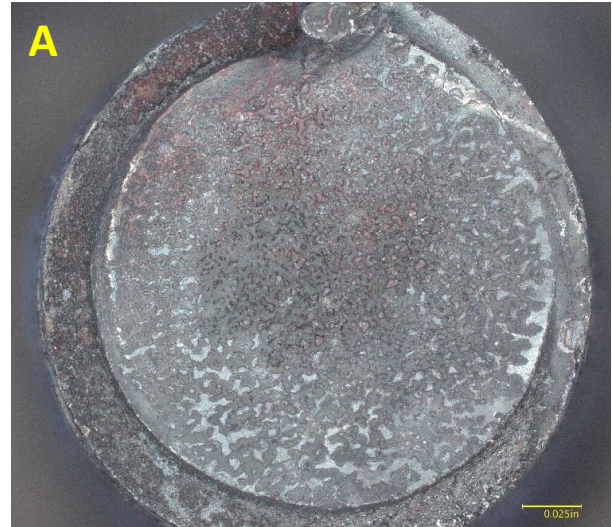
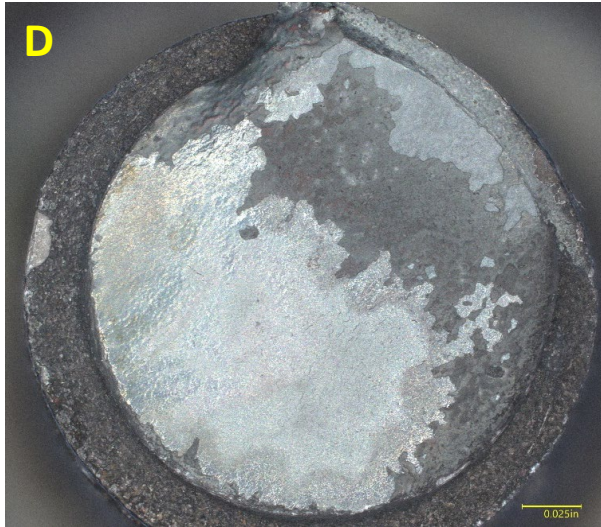


Figure 7. Digital microscope images of the fracture surfaces on the attachment bolts after cleaning.

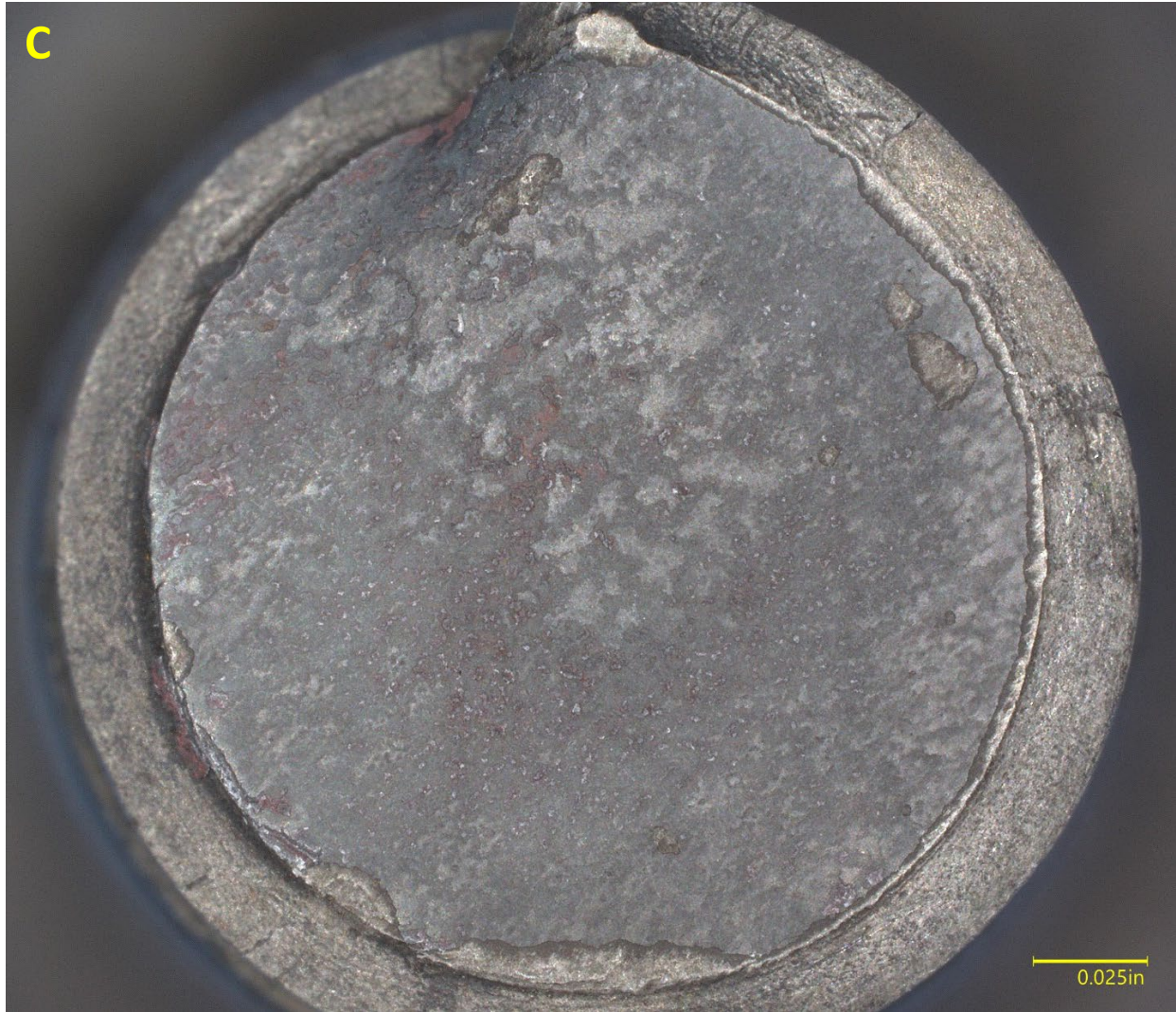


Figure 8. Digital microscope image of the fracture surface on attachment bolt C following additional cleaning.

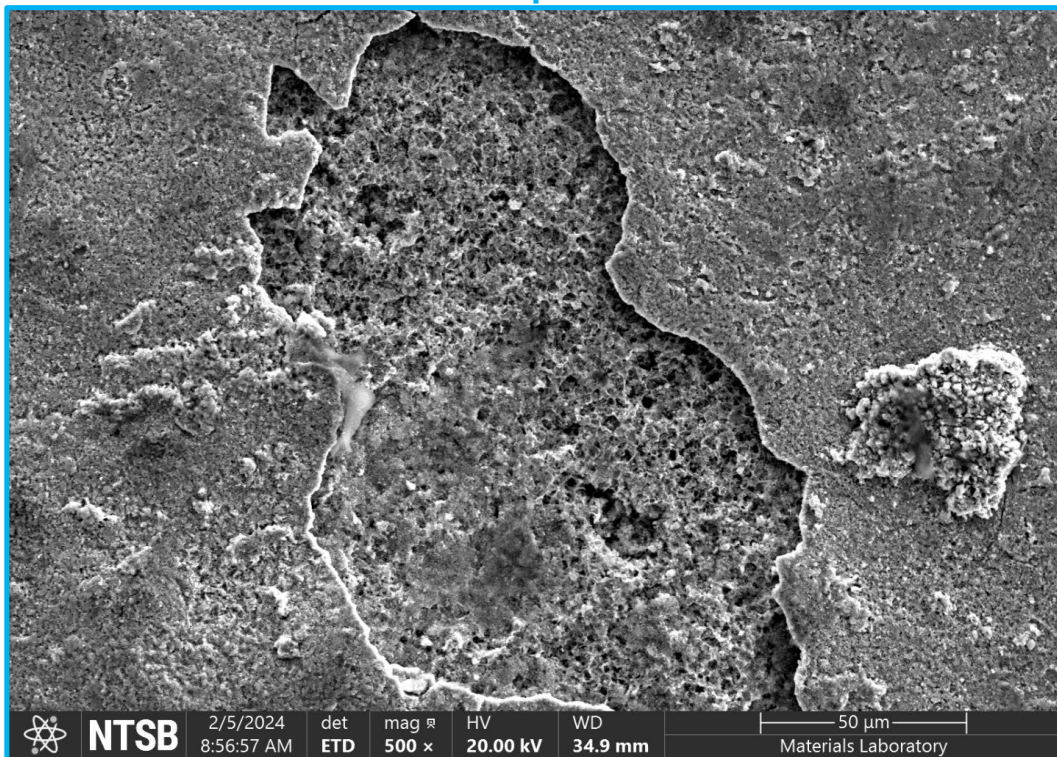
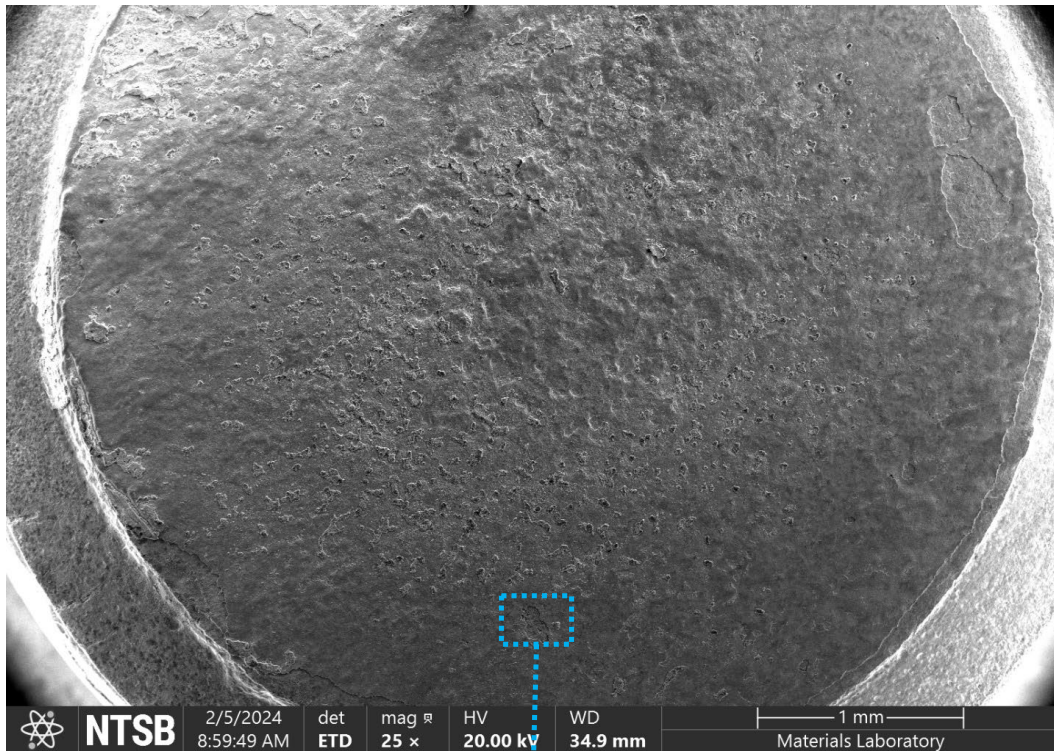


Figure 9. SEM images of the fracture surface on attachment bolt C following additional cleaning.

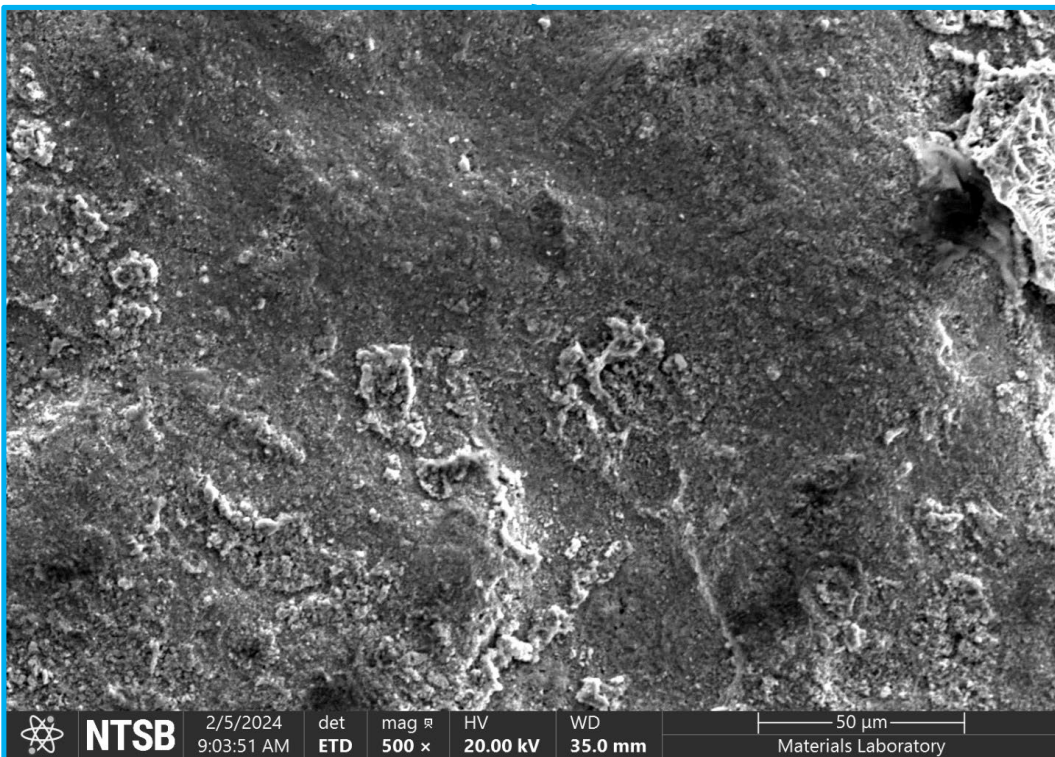
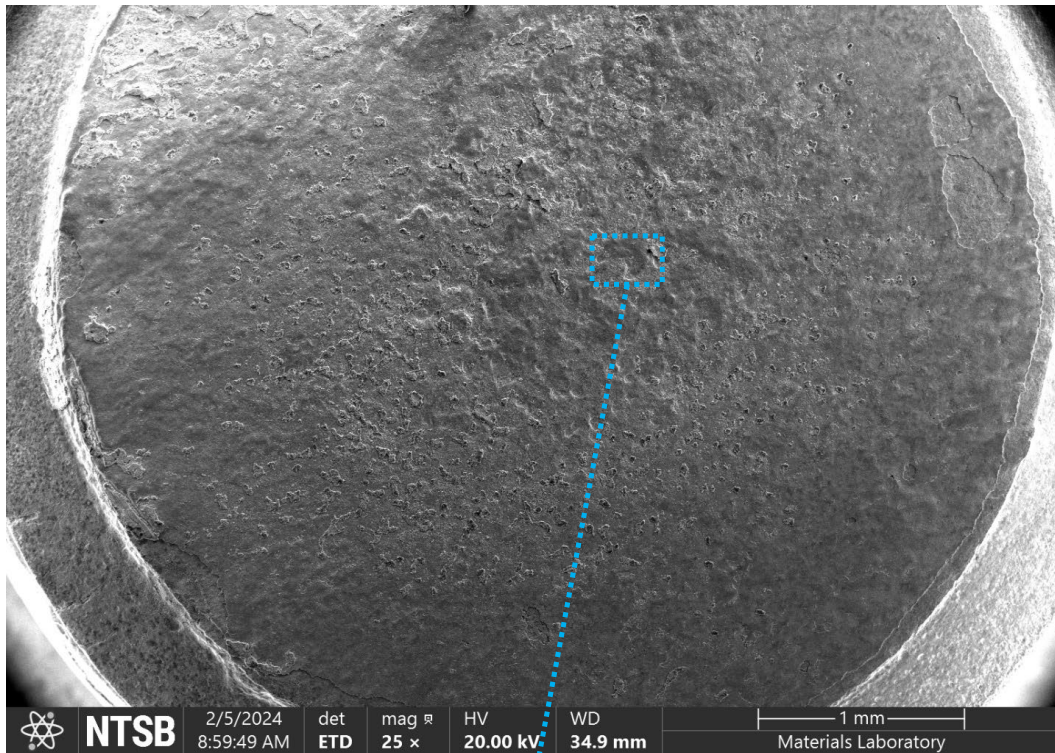


Figure 10. SEM images of the fracture surface on attachment bolt C following additional cleaning.