

National Transportation Safety Board

Office of Research and Engineering

Washington, DC 20594



ERA23LA285

MATERIALS LABORATORY

Factual Report 23-104

December 19, 2023

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A. ACCIDENT INFORMATION

Location: Yorktown Heights, New York
Date: June 29, 2023
Vehicle: Diamond DA 40 NG, N44HH
Investigator: Daniel Boggs (AS-ERA)

B. COMPONENTS EXAMINED

Turbo charger induction frame housing

C. EXAMINATION PARTICIPANTS

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

D. DETAILS OF THE EXAMINATION

The subject aircraft crashed landed in a grassy area after experiencing a gradual loss of engine power while in flight. During the after-accident aircraft examination, the turbo charger induction frame housing was found separated and subsequently submitted to the NTSB Materials Laboratory in Washington, D.C. for examination.

The air outlet flange had separated from the housing, as shown in Figure 1. The fracture was relatively straight on the outboard side, before proceeding at an angle following the curve of the housing outer diameter. The mating fracture surfaces are shown in Figure 2 with the straight portions indicated by white brackets.

Digital microscope images of the fracture surface on the separated flange piece are shown in Figures 3 and 4. The top image in Figure 3 shows the appearance of the fracture surface as-received, while the bottom image shows the appearance after cleaning with mild detergent and then immersed in an ultrasonic methanol bath. The macro features of the straight portion of fracture surface were consistent with fatigue cracking. The fatigue cracking emanated from the outer surface of the housing and proceeded circumferentially until the red dotted line. Steps on the fracture surface (yellow arrows, Figure 4) indicate fatigue cracking on multiple planes had coalesced into one main fatigue crack. The remainder of the fracture surface had macro features consistent with overstress.

The cleaned flange piece fracture surface was examined using a Thermo Scientific Apreo 2 field emission scanning electron microscope (SEM). SEM images of the fracture surface are shown in Figures 5 and 6. Progressive crack arrest marks consistent with fatigue were observe in the straight area on the fracture surface. The

crack arrest marks emanated from the outer surface of the housing in multiple locations. The white arrows indicate the direction of propagation of several of the cracks emanating from the outer surface. The remainder of the fracture surface had ductile dimple features consistent with overstress.

Figure 7 shows digital microscope images of the outer surface on the housing adjacent to the fracture surface. The outer surface had a rough appearance consistent with an as-cast surface. The straight fracture proceeded through the approximate center of a zero digit in the part number that was embossed on the outer surface of the housing casting. Figure 8 shows a comparison of digital microscope images of the housing outer surface and the straight fracture surface. The red dashed lines align the digit features on the two surfaces. Some of the fatigue cracking emanated from the digit features, as well as areas next to the digit. The embossed digit and other raised areas on the rough outer surface of the housing likely acted as stress risers for fatigue crack initiation.

Submitted by:

Adrienne V. Lamm
Materials Engineer

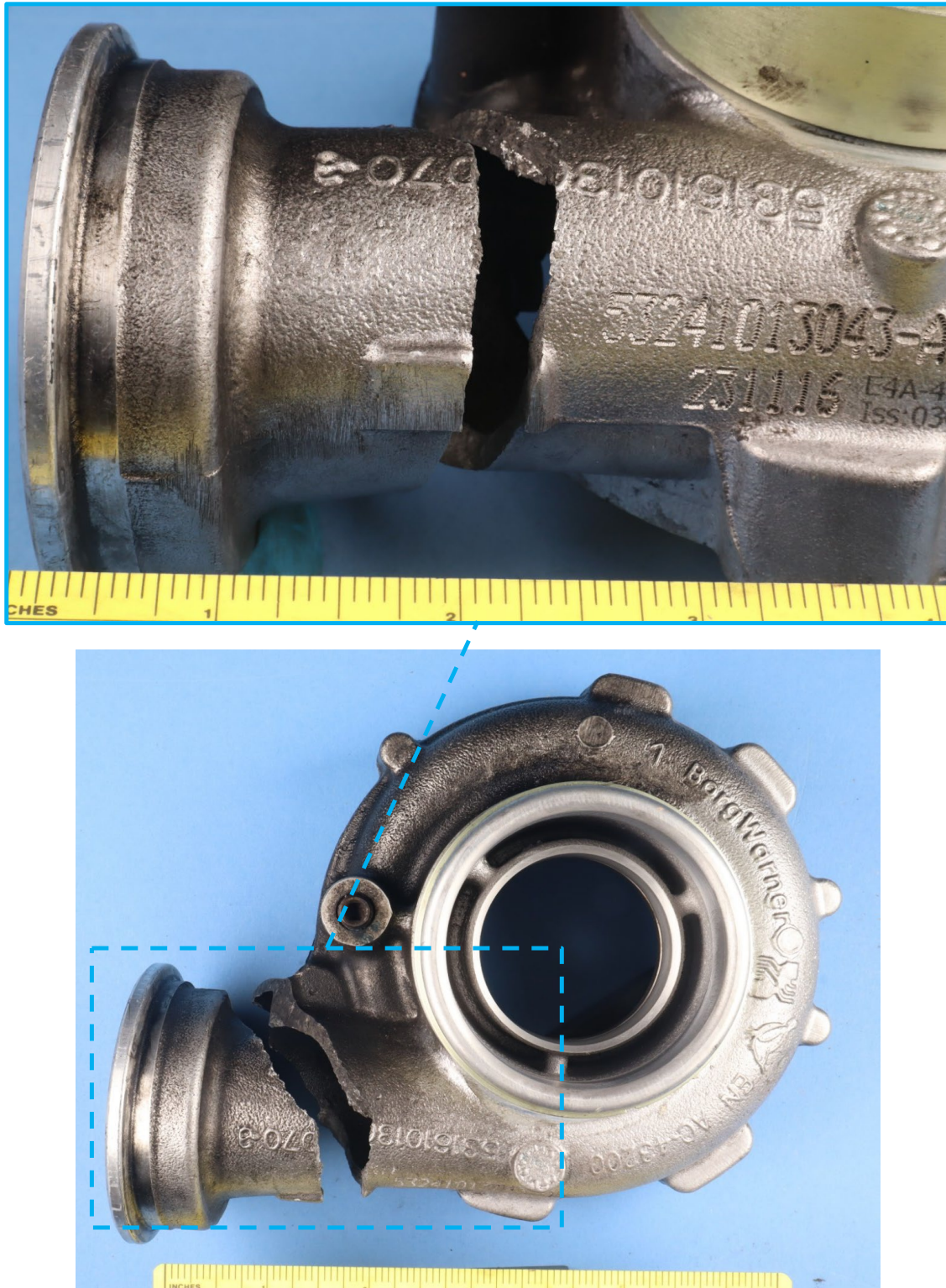


Figure 1. Overall (bottom) and close-up (top) photos of the separated air outlet flange on the submitted turbo charger induction housing.



Figure 2. Close-up photos of the mating housing fracture surfaces with the straight portions indicated by white brackets.

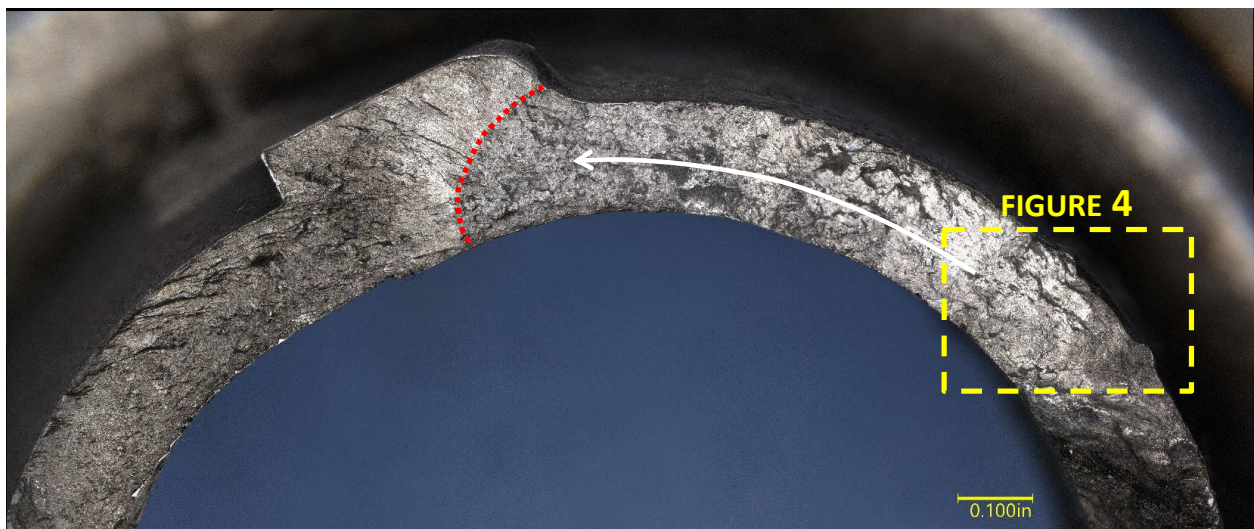
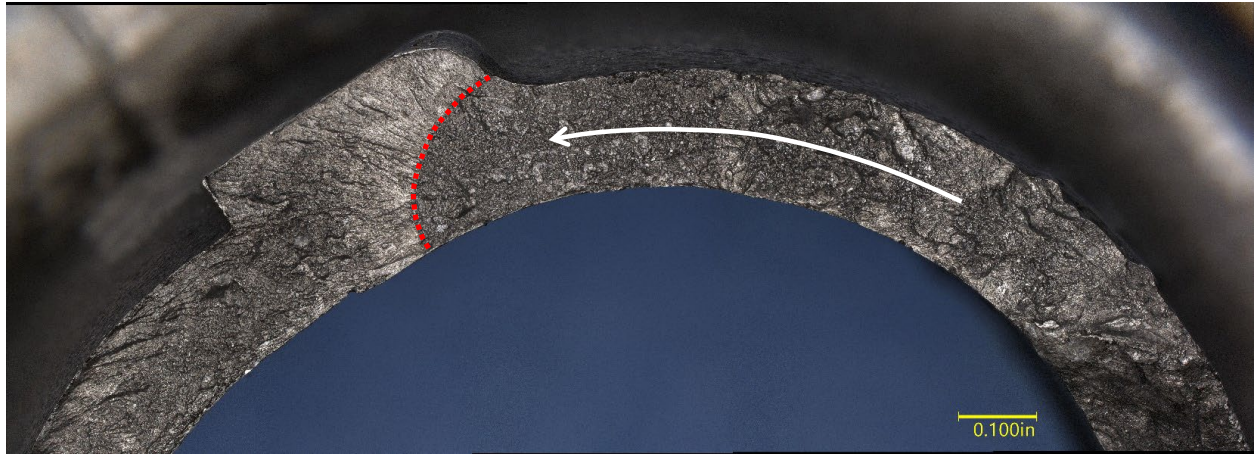


Figure 3. Digital microscope images of the fracture surface on the flange piece before (top) and after (bottom) cleaning. The white arrows and red dotted lines indicate the direction and end of fatigue crack propagation, respectively.

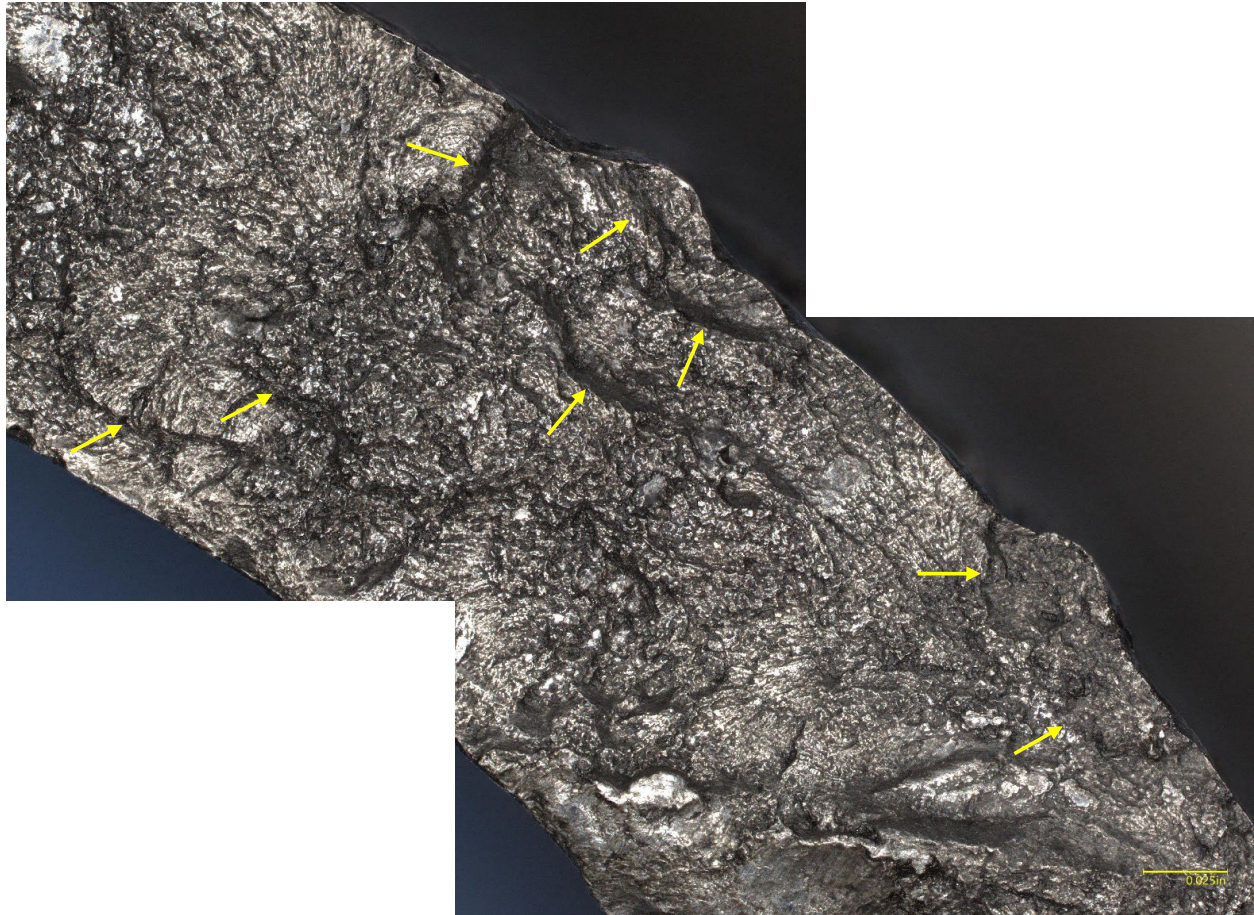


Figure 4. Digital microscope image of the fracture surface on the flange piece with yellow arrows pointing to steps on the fracture surface.

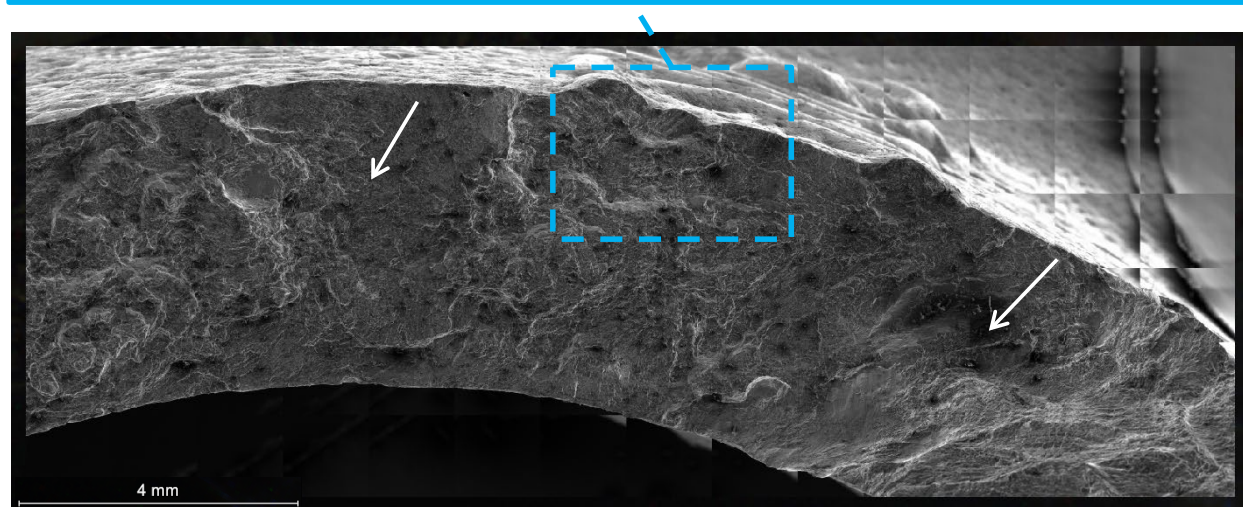
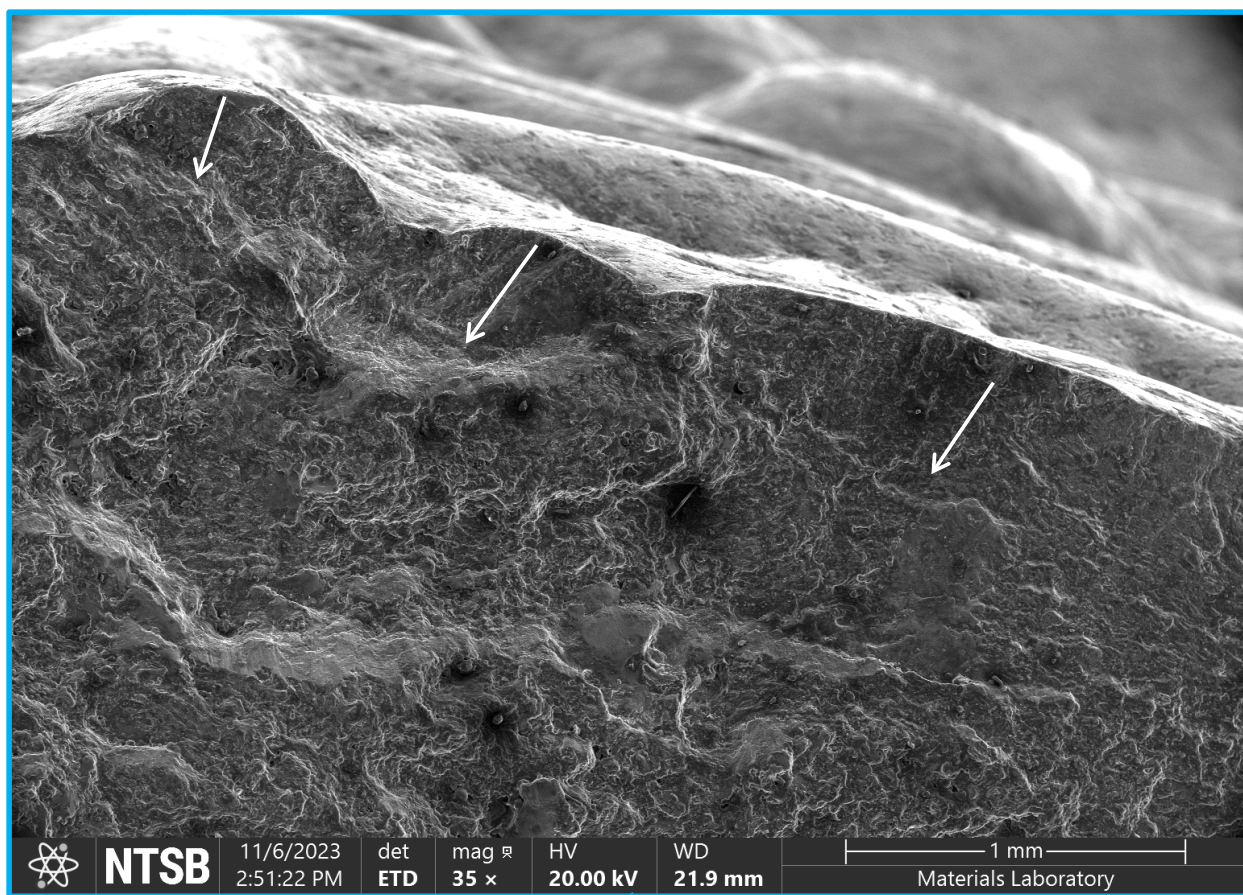


Figure 5. Secondary electron SEM images of the fracture surface on the flange piece with white arrows indicating the direction of crack propagation from multiple fatigue crack initiations.

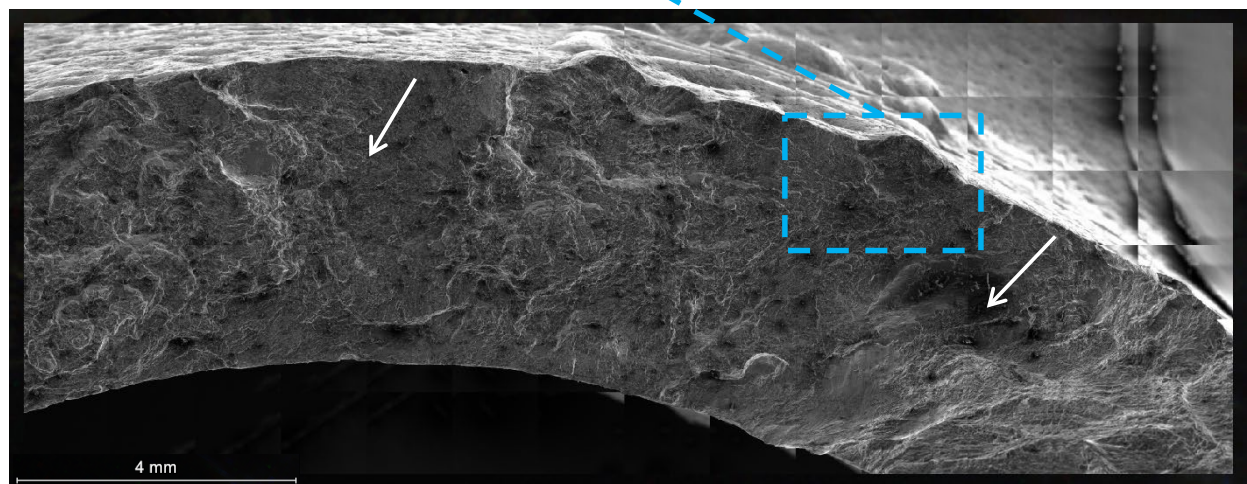
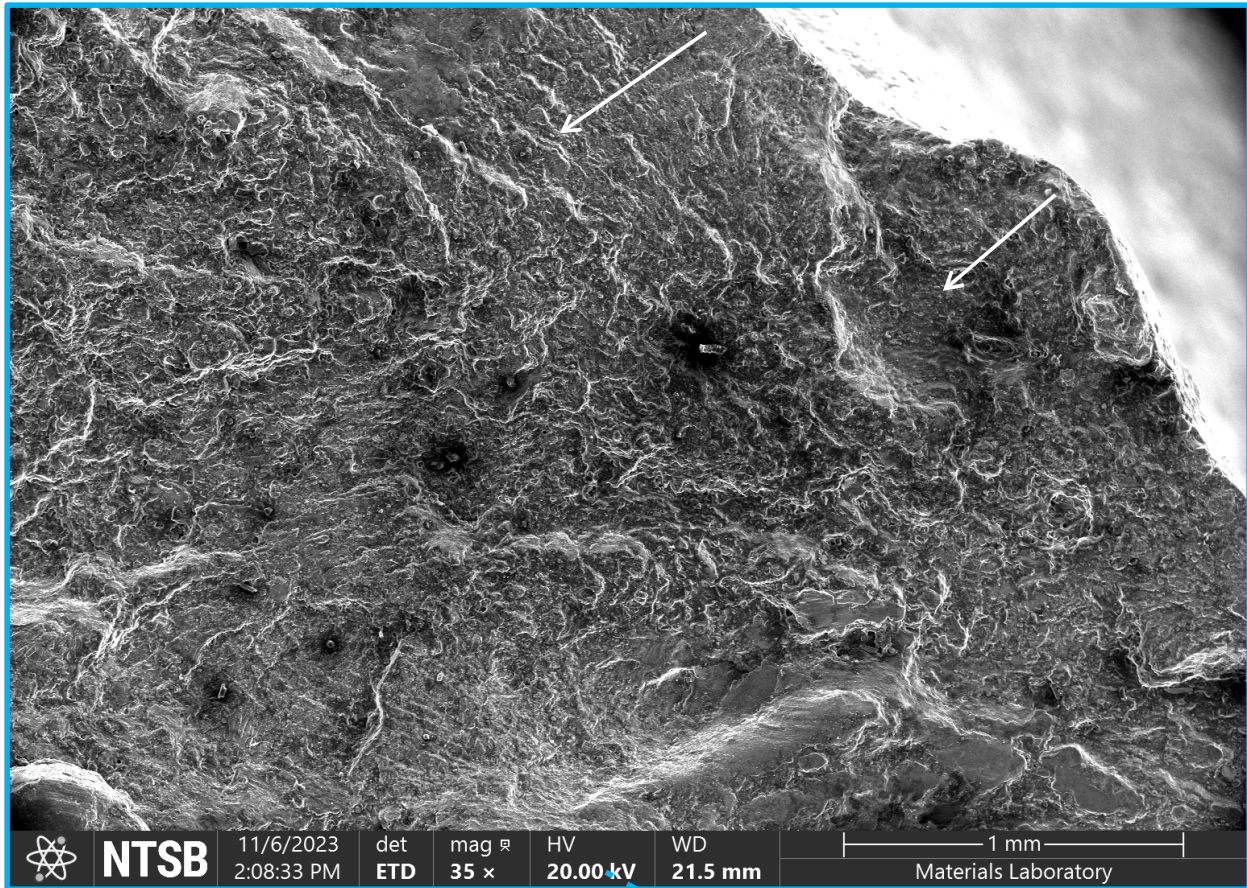


Figure 6. Secondary electron SEM images of the fracture surface on the flange piece with white arrows indicating the direction of crack propagation from multiple fatigue crack initiations.

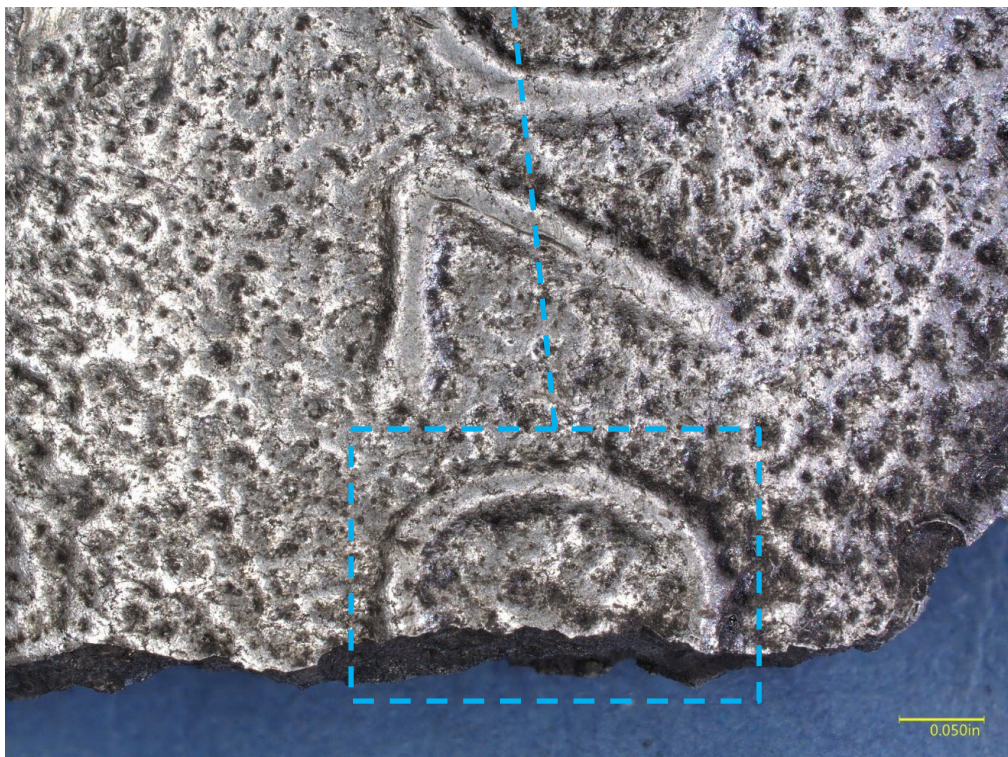
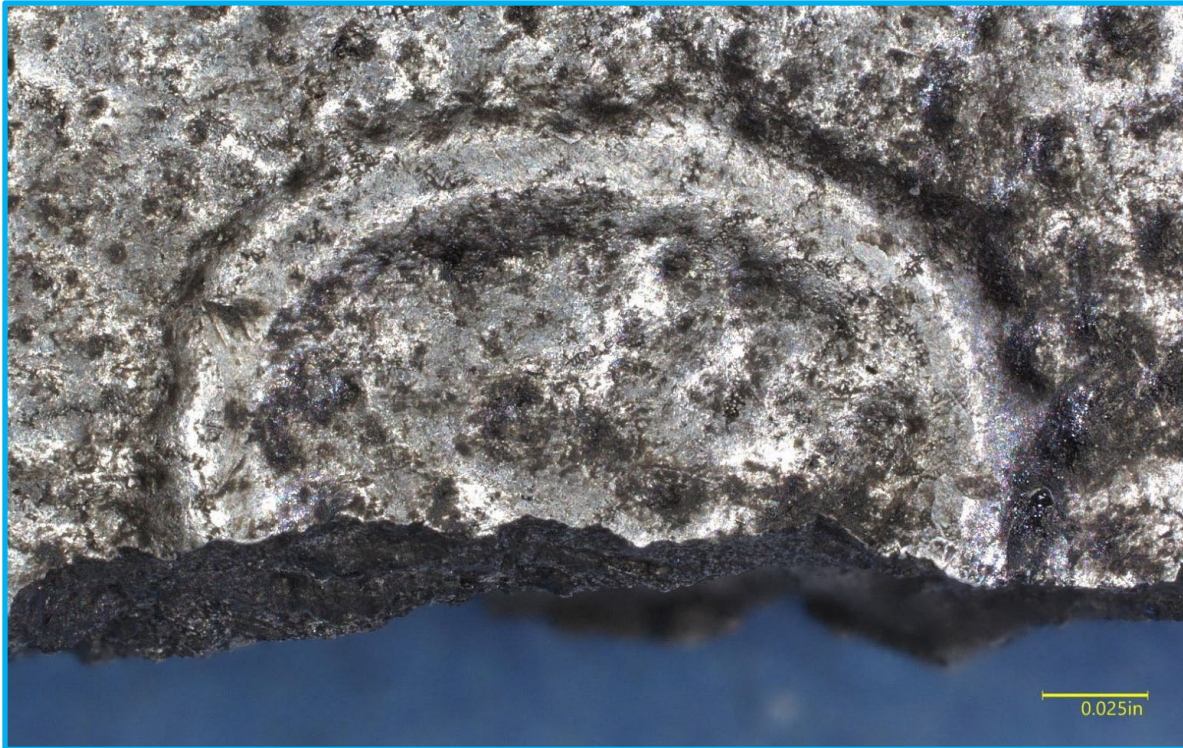


Figure 7. Digital microscope images of the outer surface on the housing adjacent to the fracture surface.

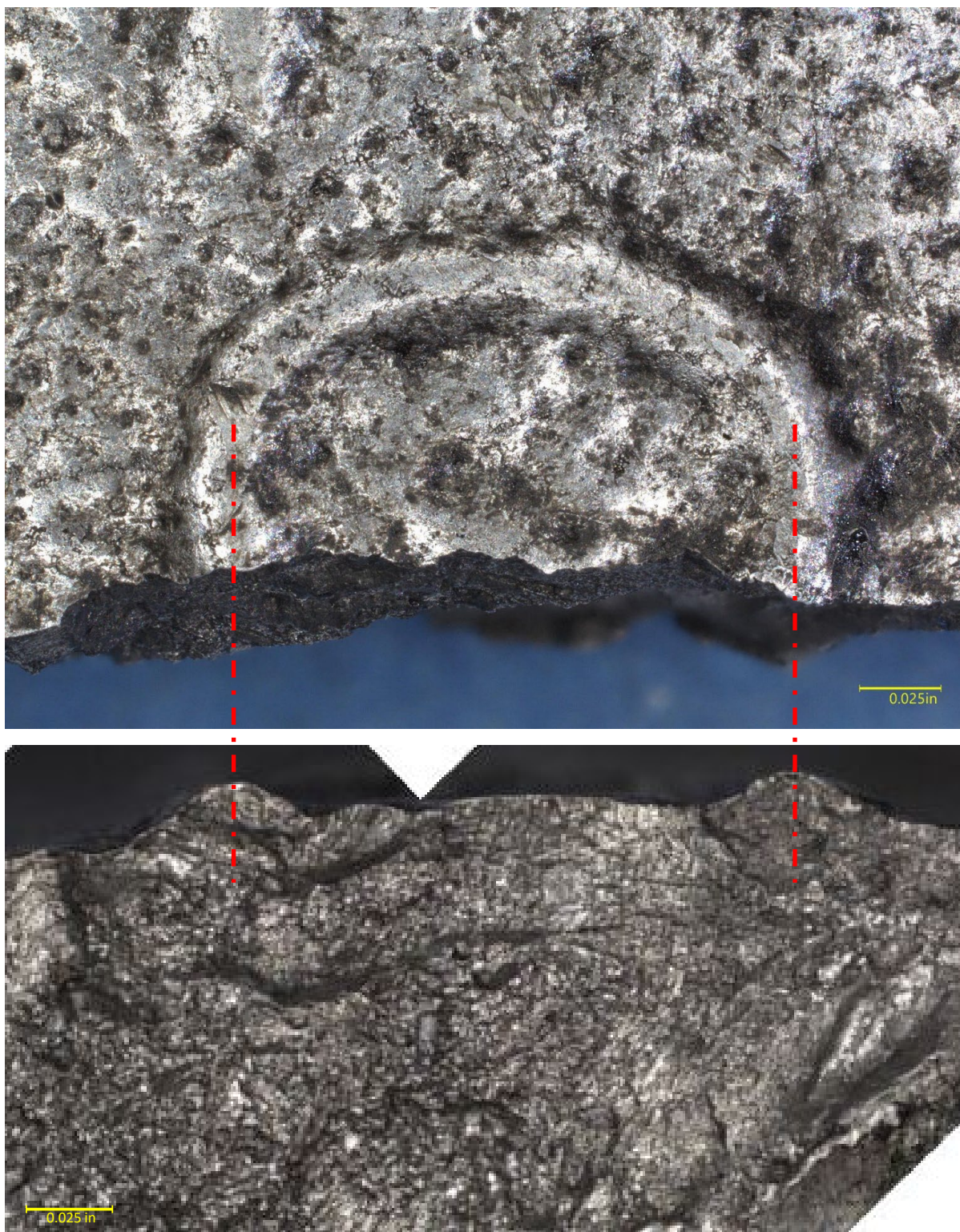


Figure 8. Comparison of digital microscope images of the outer surface on the housing adjacent to the fracture surface and the fracture surface. The red dashed lines align the features of the embossed zero digit on the housing surface.