

# NATIONAL TRANSPORTATION SAFETY BOARD

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



January 28, 2019

## MATERIALS LABORATORY FACTUAL REPORT

Report No. 18-092

### 1. ACCIDENT INFORMATION

Place : Des Moines, Iowa  
Date : August 13, 2016  
Vehicle : Cirrus SR20, N314BF  
NTSB No. : CEN16LA320  
Investigator : Andrew Todd Fox, AS-CEN

### 2. COMPONENTS EXAMINED

Fragment of induction tube  
Fragment of induction tube flange

### 3. DETAILS OF THE EXAMINATION

On August 13, 2016, about 1001 central daylight time, a Cirrus SR20 single-engine airplane experienced a partial loss of engine power shortly after takeoff. The pilot reported that during initial climb, he heard and felt a sudden reduction in engine power. The pilot deployed the Cirrus Airframe Parachute System (CAPS) and descended into powerlines and terrain. The airplane was subsequently destroyed by a postimpact fire. The pilot and 2 passengers sustained minor injuries.

According to airplane logbook entries, the most recent annual inspection was completed on May 19, 2016 at 1565.6 hours total airframe time. As of the annual inspection, the engine had accumulated 555.2 hours since being rebuilt at the factory on March 20, 2009. According to the pilot, the airplane had accumulated about 66.5 hours since the last annual inspection.

The engine and propeller were not damaged by the postimpact fire. The accident airplane was powered by a Continental IO-360-ES16B engine, S/N 1000059, which drove a two-blade Hartzell model BHC-J2YF-1BF/F7694 constant speed propeller.<sup>1</sup> From the initial engine teardown, the cylinder No. 3 intake tube (P/N 655224-1) had fractured at the cylinder mounting flange. This fractured intake tube was sent to the NTSB Materials Laboratory for additional examination.

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<sup>1</sup> The Continental IO-360-ES16B is a fuel-injected air-cooled, horizontally-opposed six-cylinder aircraft engine with a rated 210 hp at 2800 rpm, manufactured by Continental Motors, headquartered in Mobile, AL.

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Figure 1 shows the #3-cylinder intake tube components, as received. The induction tube consisted of a metal alloy tube that was curved, affixed to an orange-colored rubber boot. The boot was stamped with the following markings: "642917-16 REV 1" and "3Q08" (see Figure 2). As shown in Figure 1, the mounting flange of the tube had fractured from the main body of the tube. An additional attachment flange, also shown in Figure 1, did not exhibit any discernible damage.

Several measurements of the tube were taken, based on the requirements from the drawing, P/N 655224, Revision C. It should be noted that the tube was deformed in multiple directions such that measurements at various locations produced inconstant data. The inner diameter measured 1.624 inches, and the outer diameter measured between 1.742 and 1.767 inches. The tube thickness ranged between 0.705 and 0.735 inches. The drawing dimension AB measured 2.822 inches, and the AC line measured approximately 2.6 inches.

Figure 3 shows the mating sides of the induction tube fracture surface from the mounting flange (3a) and the tube (3b) sides. The fracture was circumferential in orientation and was perpendicular to the tube direction. The flange had also fractured in two additional locations longitudinally, creating two flange fragments.

Figures 4 through 7 show closer views of the mating fracture surfaces. In general, the fracture surfaces exhibited a flat orientation, with some areas exhibiting an approximately 45° orientation. As shown in Figures 5 and 7, most of the fracture surfaces exhibited smearing and rub marks, consistent with post-fracture damage. These damaged regions appeared shiny in contrast to the surrounding less damaged or undamaged portions of the fracture surface. These undamaged areas exhibited a dull luster and rougher surface texture.

The flange side fracture surface was examined using a scanning electron microscope (SEM). As described previously, much of the fracture surface had been damaged to the extent that typical fracture features had been obliterated. However, in isolated areas, some fracture features could be discerned, as shown in Figures 8 and 9. As illustrated in these figures, the undamaged portions of the fracture surface showed striations, consistent with fatigue crack propagation. The character and spacing of the striations were consistent with high-cycle fatigue.

An additional area near the edge of the fracture surface is shown in Figures 10 and 11. This undamaged portion of the fracture surface also exhibited fine fatigue striations. However, the likely initiation sites of the fatigue cracking had been destroyed by post-fracture smearing. In addition, no features consistent with other fracture modes were observed on the undamaged areas of the fracture surface.

A section of the fractured flange through the fracture surface was mounted and polished. Figure 12 shows a typical area of the flange microstructure, which exhibited a two-phase structure consistent with wrought materials. The chemical composition of the tab was inspected using energy dispersive x-ray spectroscopy (EDS). The composition

was consistent with an AA 6061-series aluminum alloy. The electrical conductivity and hardness were inspected per ASTM E1004 and ASTM E384, respectively.<sup>2,3</sup> The conductivity averaged 42.5% IACS, and the hardness averaged 46 HV<sub>500</sub>. These data were consistent with those typical of this alloy in the annealed condition.

Erik M Mueller  
Materials Research Engineer

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<sup>2</sup> ASTM E1004 – *Standard Test Method for Determining Electrical Conductivity Using the Electromagnetic (Eddy-Current) Method*. ASTM International, West Conshohocken, PA

<sup>3</sup> ASTM E384 – *Standard Test Method for Knoop and Vickers Hardness of Materials*. ASTM International, West Conshohocken, PA

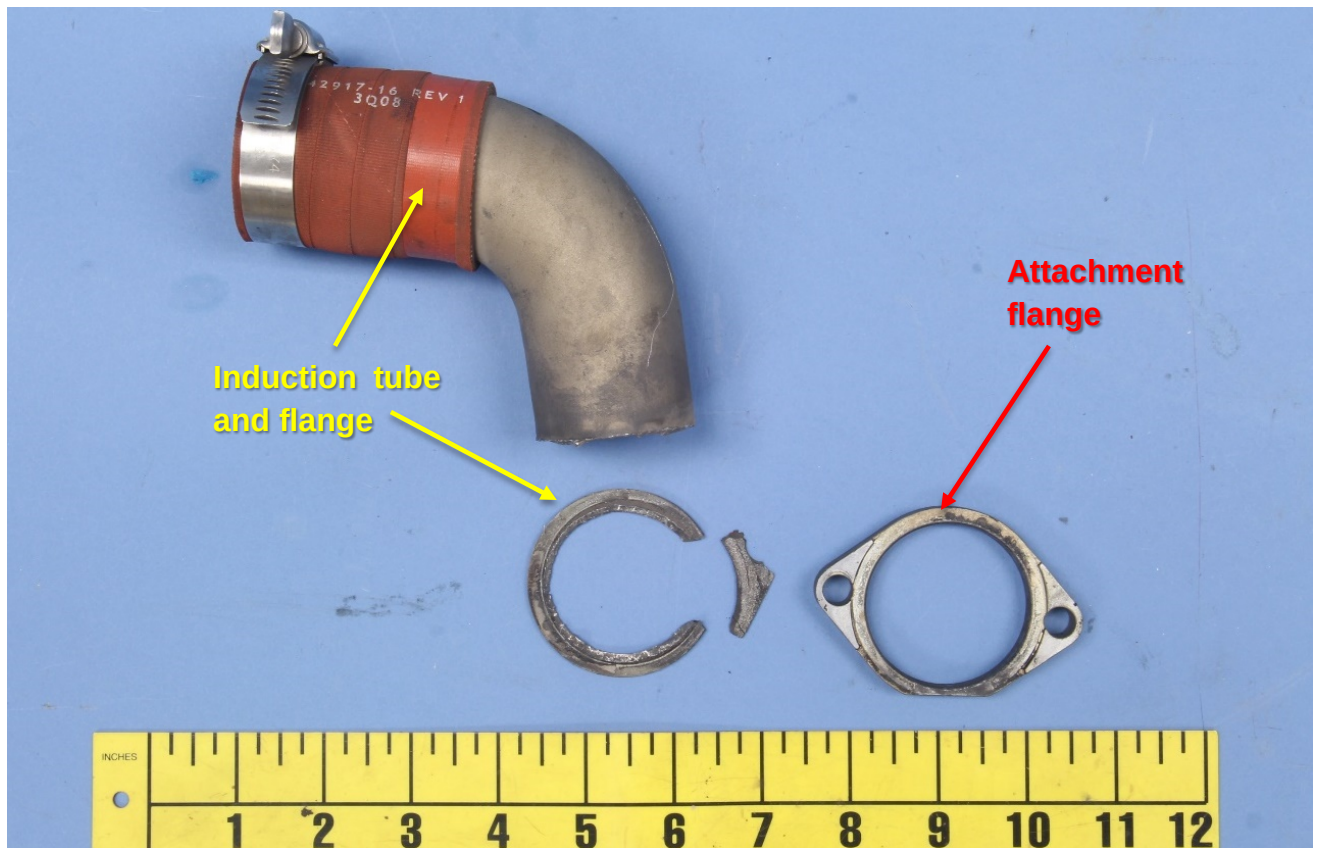


Figure 1 – The pieces of the fractured #3 induction tube and attachment flange, as received.



Figure 2 – Markings on the orange rubber connector on the opposite side of the induction tube.

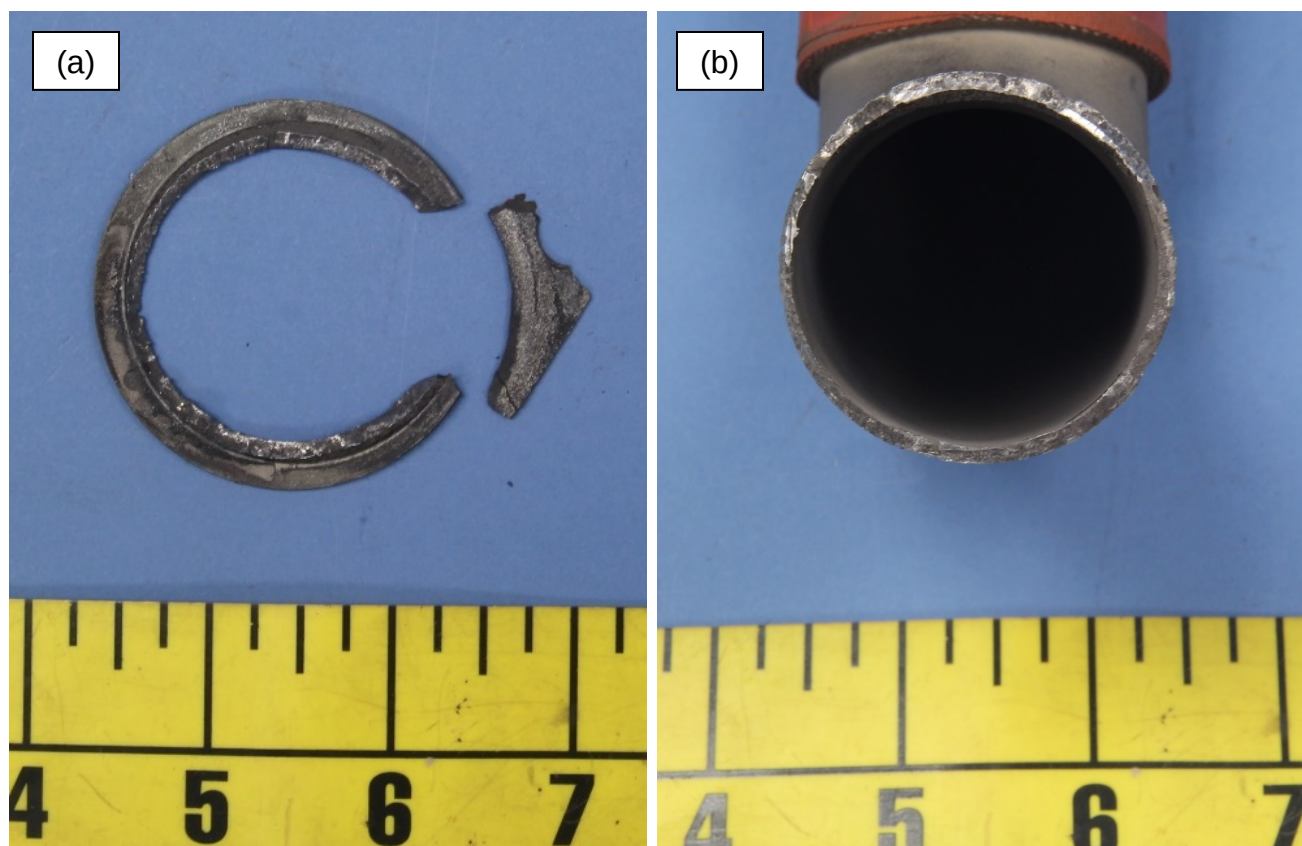


Figure 3 – The fracture surfaces of the induction tube from (a) the fractured flange and (b) the tube.



Figure 4 – Closer view of the tube side fracture surface.

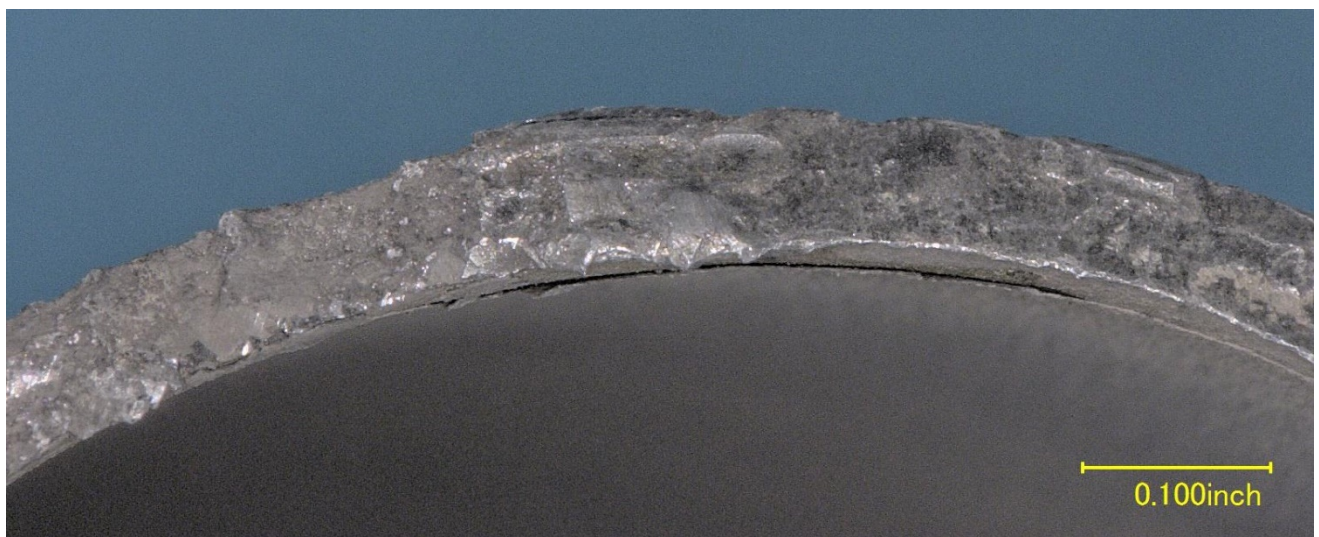


Figure 5 – View of the upper portion of the tube fracture surface, showing post-fracture damage.



Figure 6 – The fracture surface of the fractured tube flange.

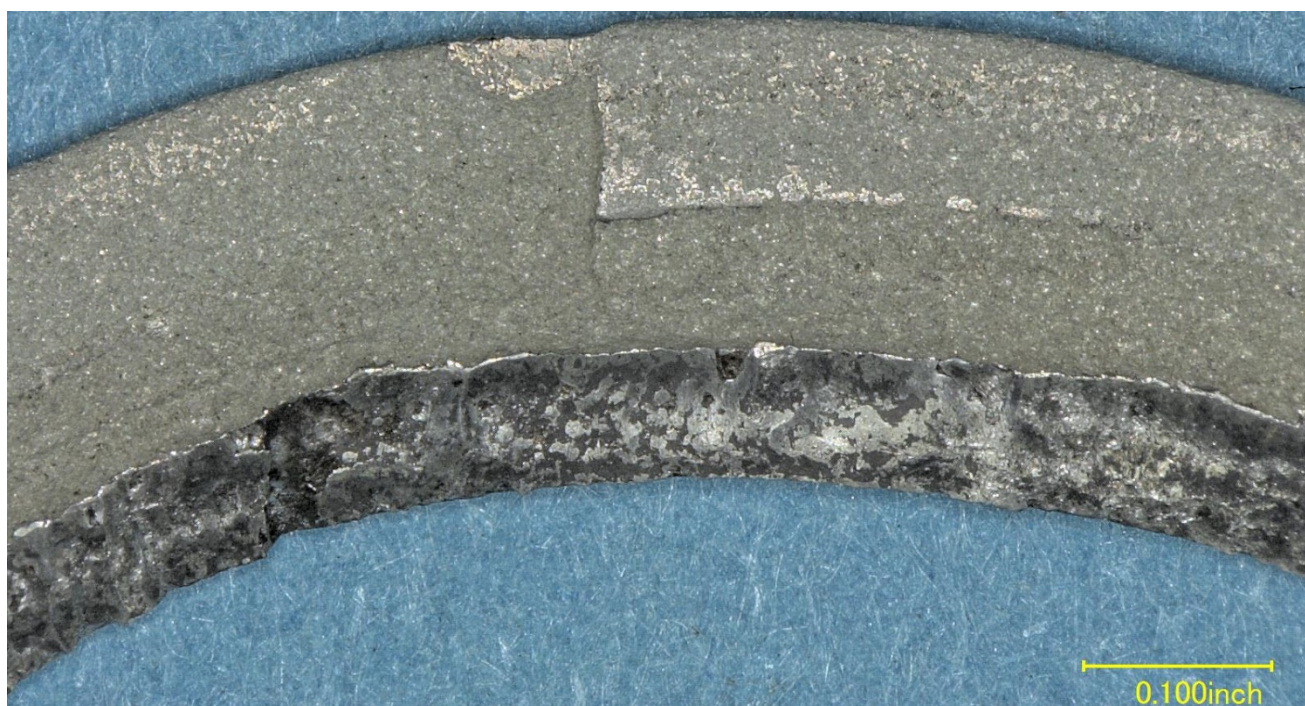


Figure 7 – Closer view of part of the flange fracture surface.

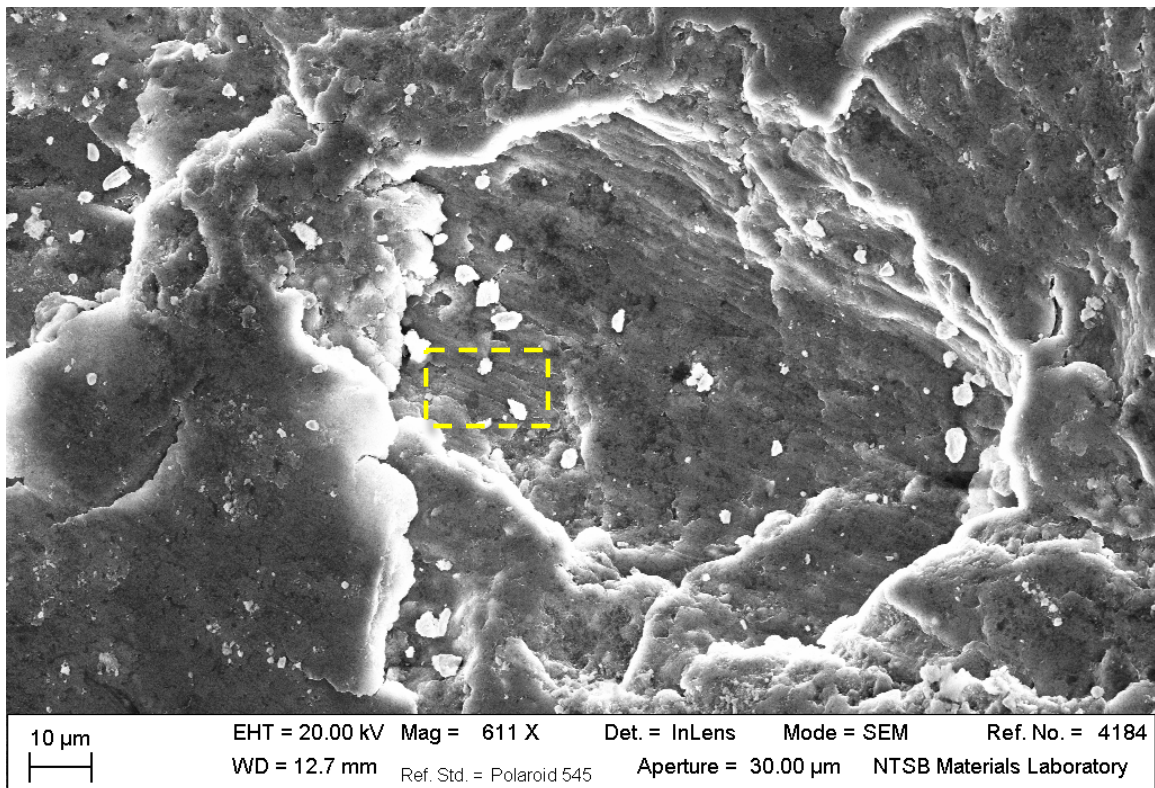


Figure 8 – Secondary electron (SE) micrograph showing an undamaged part of the flange fracture surface. The boxed area is shown in Figure 9.

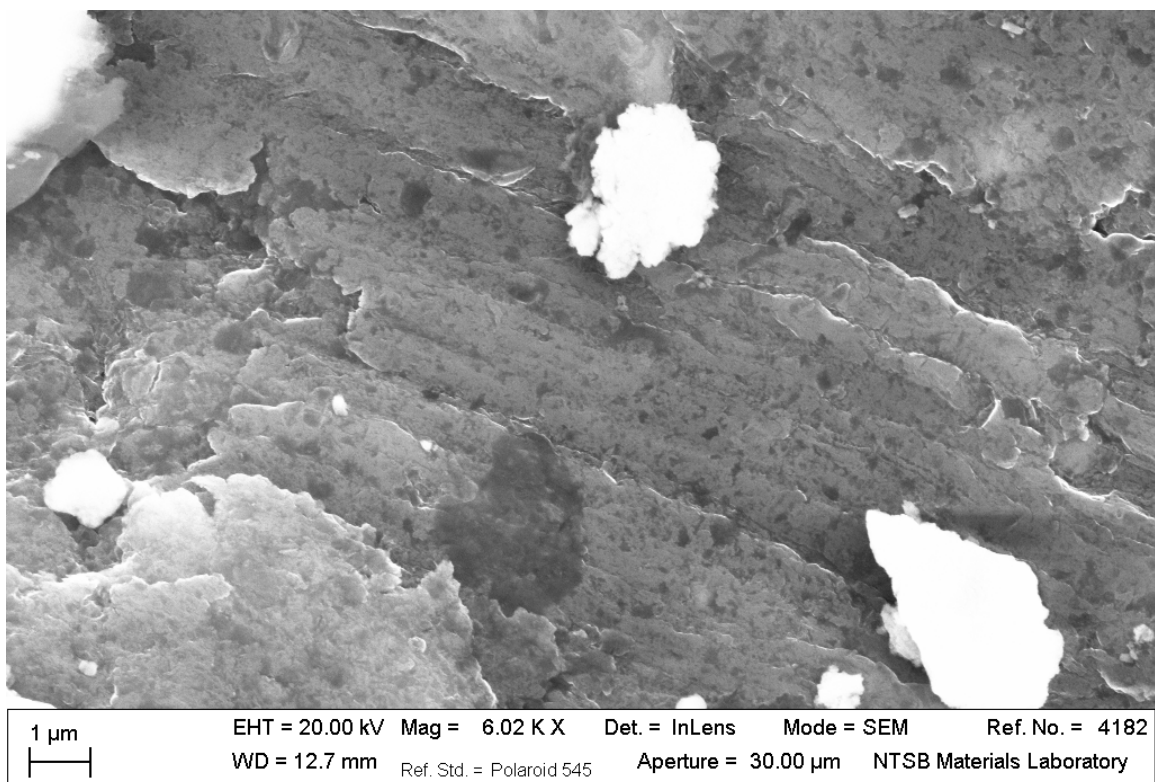


Figure 9 – SE micrograph showing fatigue striations from the boxed area in Figure 8.

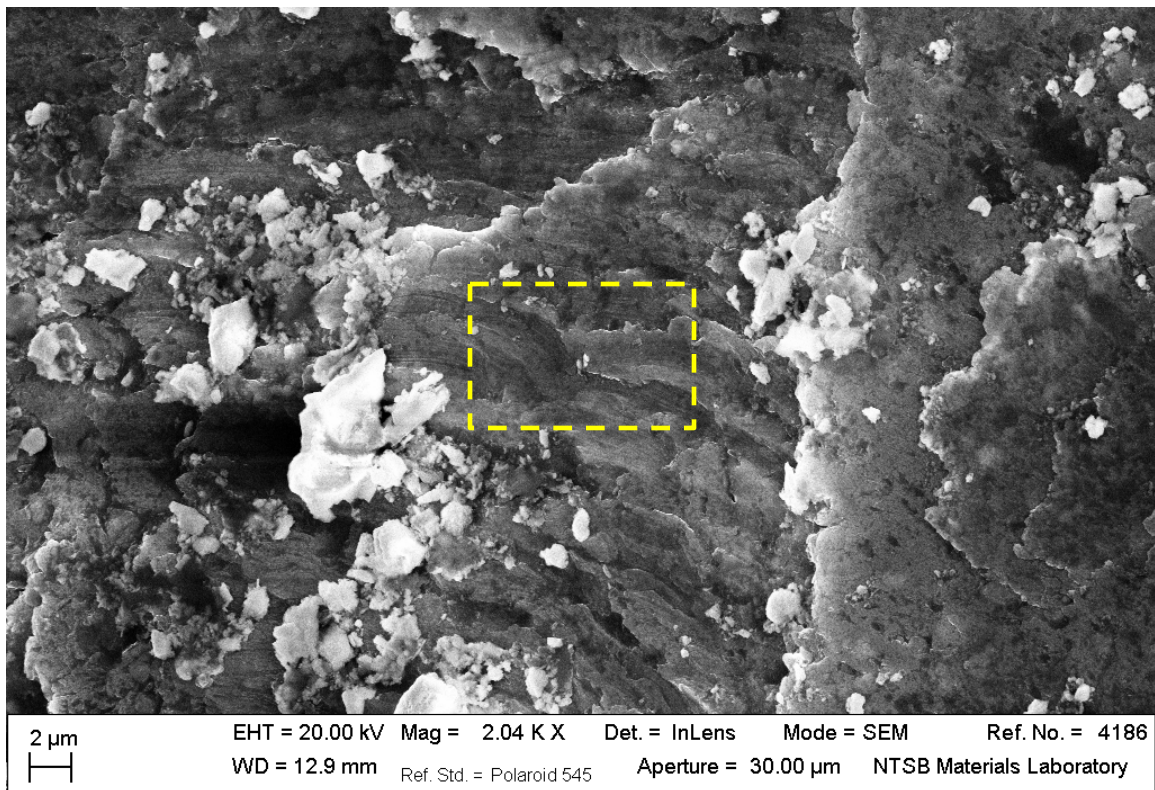


Figure 10 – SE micrograph of fatigue striations near the fracture surface edge.

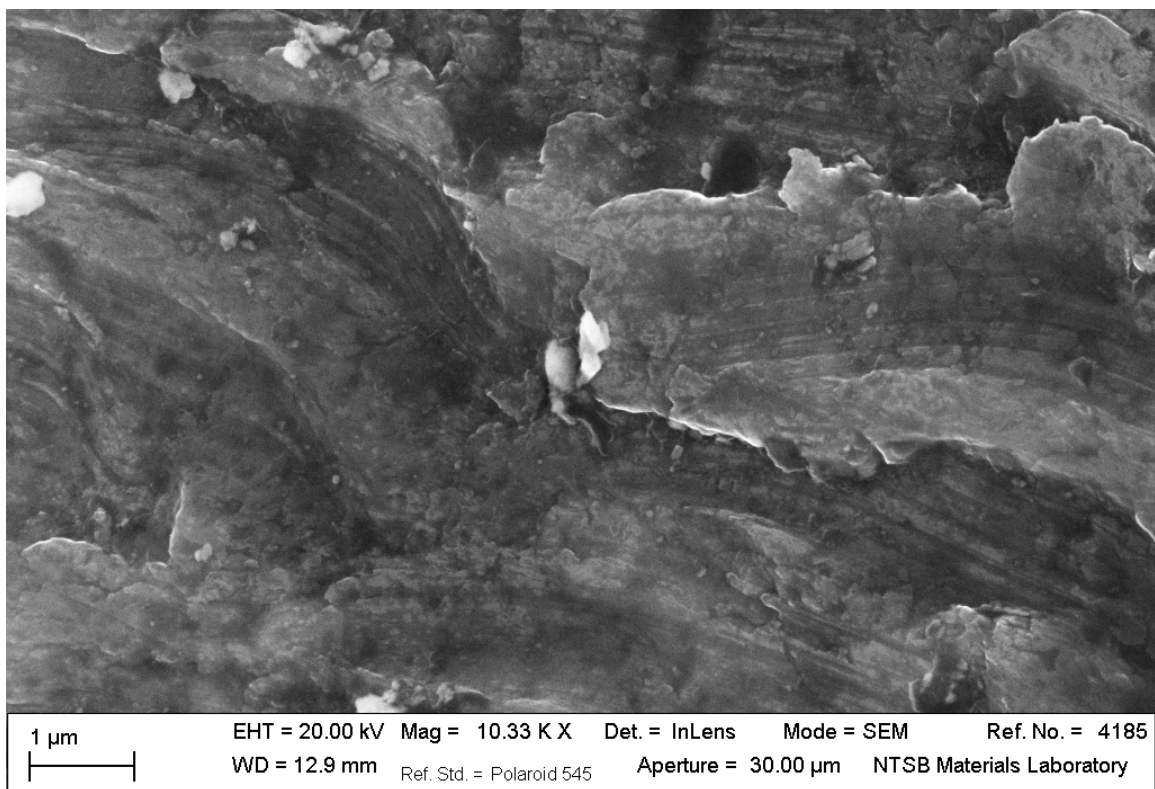


Figure 11 – SE micrograph of the yellow boxed area in Figure 10, showing fine fatigue striations.

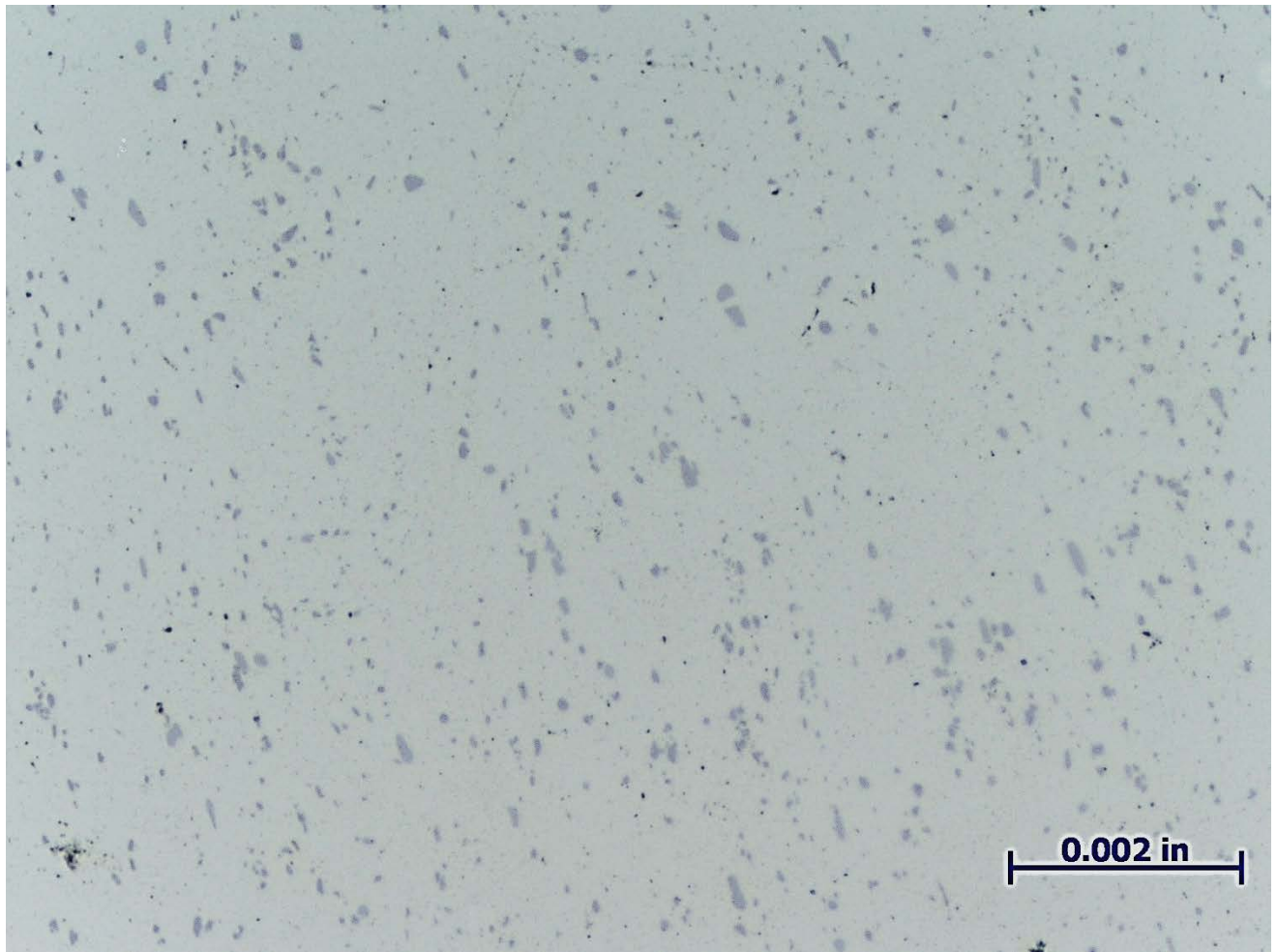


Figure 12 – Bright-field (BF) optical metallograph of the flange microstructure (~500X, as polished).