

NATIONAL TRANSPORTATION SAFETY BOARD

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

December 22, 2020



MATERIALS LABORATORY FACTUAL REPORT

Report No. 20-055

1. ACCIDENT INFORMATION

Place : Coeur D'Alene, Idaho
Date : June 18, 2020
Vehicle : Cessna 310B, N6602B
NTSB No. : WPR20LA187
Investigator : Maja Smith, AS-WPR

2. COMPONENTS EXAMINED

Remnants of left-hand main landing gear drive tube

3. DETAILS OF THE EXAMINATION

On June 18, 2020, about 1345 Pacific daylight time, a Cessna 310B airplane was substantially damaged while landing at Coeur d'Alene Airport near Coeur d'Alene, ID. The pilot, who was not injured, reported that after landing, the left main landing gear (MLG) collapsed. The airplane slid off the runway and came to rest in an adjacent field. The left-hand main landing gear drive tube was retained and sent to the NTSB Materials Laboratory for additional examination.

Figure 1 and Figure 2 show the fractured drive tube, as received. In these figures, the tube was positioned to show the mating fracture surfaces in their positions prior to fracture. Not pictured in Figure 1 were a bolt, washer, and nut submitted separately from the fractured tube.

When positioned so that the fracture surfaces faced each other, the normally straight tube exhibited a V-shaped bend. Figure 2 and Figure 3 show closer views of the mating fracture surface and local plastic deformation features as annotated. The concave side exhibited an S-shaped buckle outward, consistent with compression-loaded fractures of ductile materials. The opposite, convex side of the fracture surface exhibited localized necking, microcracking in the paint parallel to the fracture, and a 45° slanted fracture surface. These features were consistent with tension-loaded fractures in ductile materials.

As shown in Figure 4, the tension side of the tube fracture was located at the terminus of the inboard clevis shaft. The compression side of the fracture was a few millimeters recessed from the shaft end. The opposite, outboard fracture surface of the

tube is shown in Figure 5, and from the side in Figure 6, after sectioning the fracture surface and cleaning it using acetone in an ultrasonic bath. Figure 6 shows a general bend in the tube towards the compression (buckled) side. As shown in Figure 5, the tube diameter was flattened, with parts of the tube wall bulging outward between the tension and compression sides. This was consistent with this portion of the tube being unconstrained, whereas the inboard side of the tube was constrained by the shaft of the clevis.

Figure 7 shows the tension side of the tube fracture surface. While oriented 45° from the tube direction, the surface itself was relatively flat, with dull, fibrous features. Some areas of the fracture surface had been damaged by smearing, particularly along the outer edge. In addition, surface corrosion, consistent with iron oxide (rust) was present—this was consistent with post-fracture corrosion and not consistent with a pre-existing fracture feature.

The outboard fracture surface was examined using a scanning electron microscope (SEM). Figure 8 shows a typical area of the tension side of the tube fracture surface. A closer view of this area showed dimpled rupture, as typified in Figure 9. Figure 10 shows a typical area of the compressive side of the fracture surface. This side of the tube fracture surface exhibited a local tension side and a local compressive side, consistent with the macroscopic bending direction. As shown in Figure 11, most of the fracture surface exhibited dimpled rupture, consistent with overstress fracture. The outermost portion or outer edge of the compressive side fracture surface exhibited wide-stepped banded features (Figure 12). These were consistent with the final remnant of the tube bending back and forth before complete separation. Close examination in this area found isolated areas of dimpled rupture.

The observed features were consistent with fracture of the landing gear drive tube from bending overstress at the end of the inboard clevis shaft. There were no indications of pre-existing fracture features or cracking.

The chemical composition of the sectioned tube was examined using x-ray fluorescence (XRF) and energy dispersive x-ray spectroscopy (EDS). From the data obtained using these techniques, the tube was found to be consistent with an alloy steel such as Type 4130. The hardness was inspected per ASTM E18.¹ The hardness averaged 61 HRA.

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Materials Research Engineer

¹ ASTM E18 – *Standard Test Methods for Rockwell Hardness and Rockwell Superficial Hardness of Metallic Materials*. ASTM International, West Conshohocken, PA.



Figure 1 – The left hand MLG drive tube remnants, viewed as received and positioned in their orientations at final fracture.

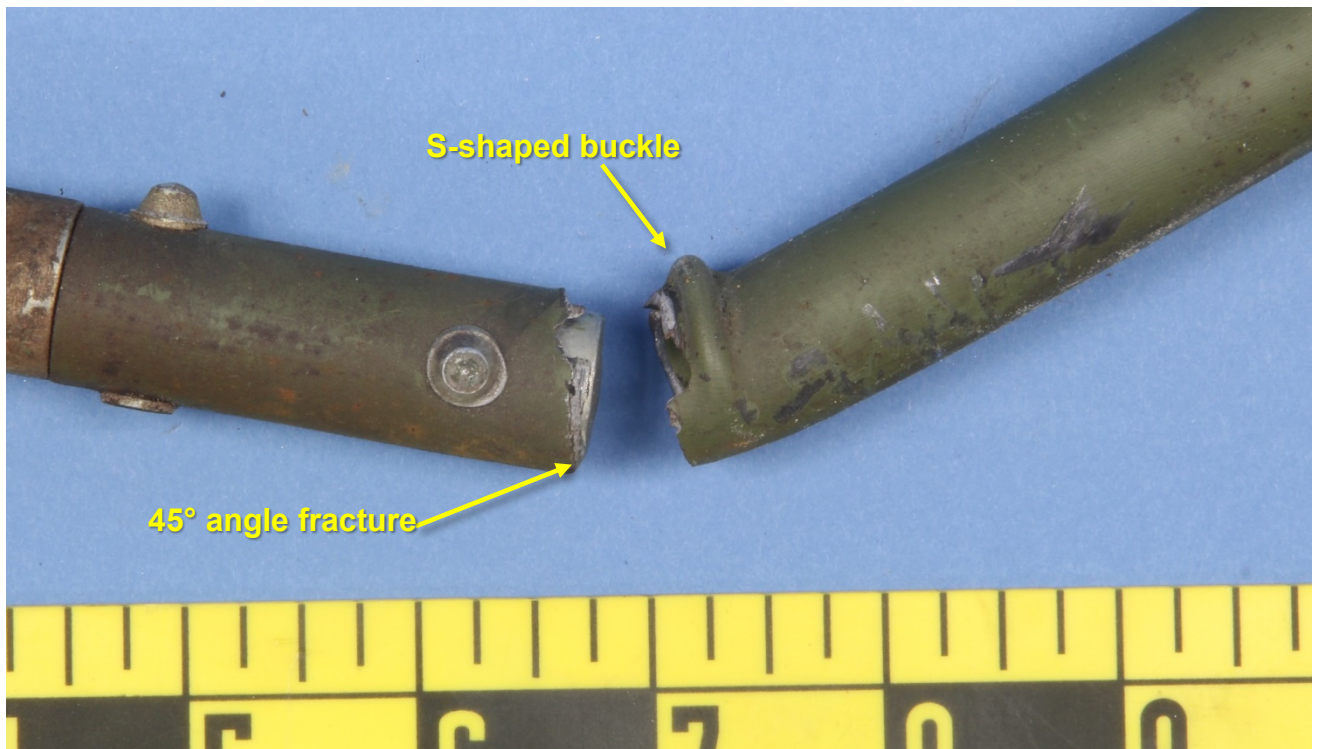


Figure 2 – Closer view of the mating tube fracture surfaces.



Figure 3 – View of the mating fracture surfaces, viewed from the compression side.



Figure 4 – View of the fracture surface from the inboard side, showing the clevis base.



Figure 5 – Closer view of the outboard fracture surface, after sectioning and cleaning.



Figure 6 – View of the outboard tube fracture surface from the side.

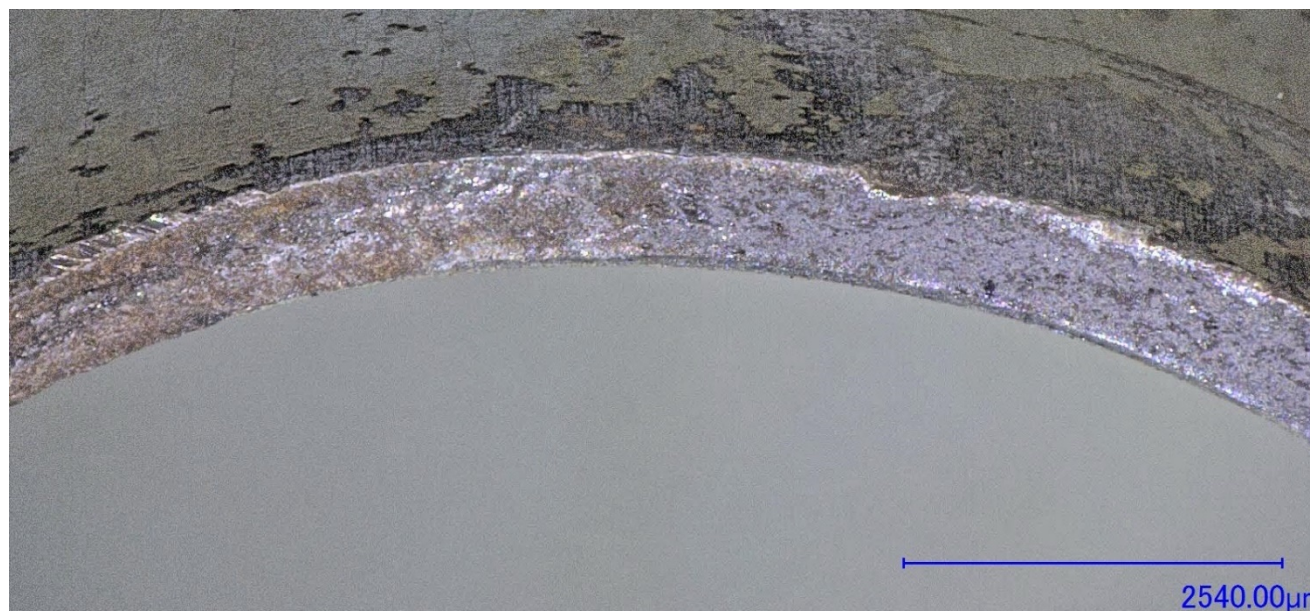


Figure 7 – Closer view of the outboard fracture surface from the tension side.

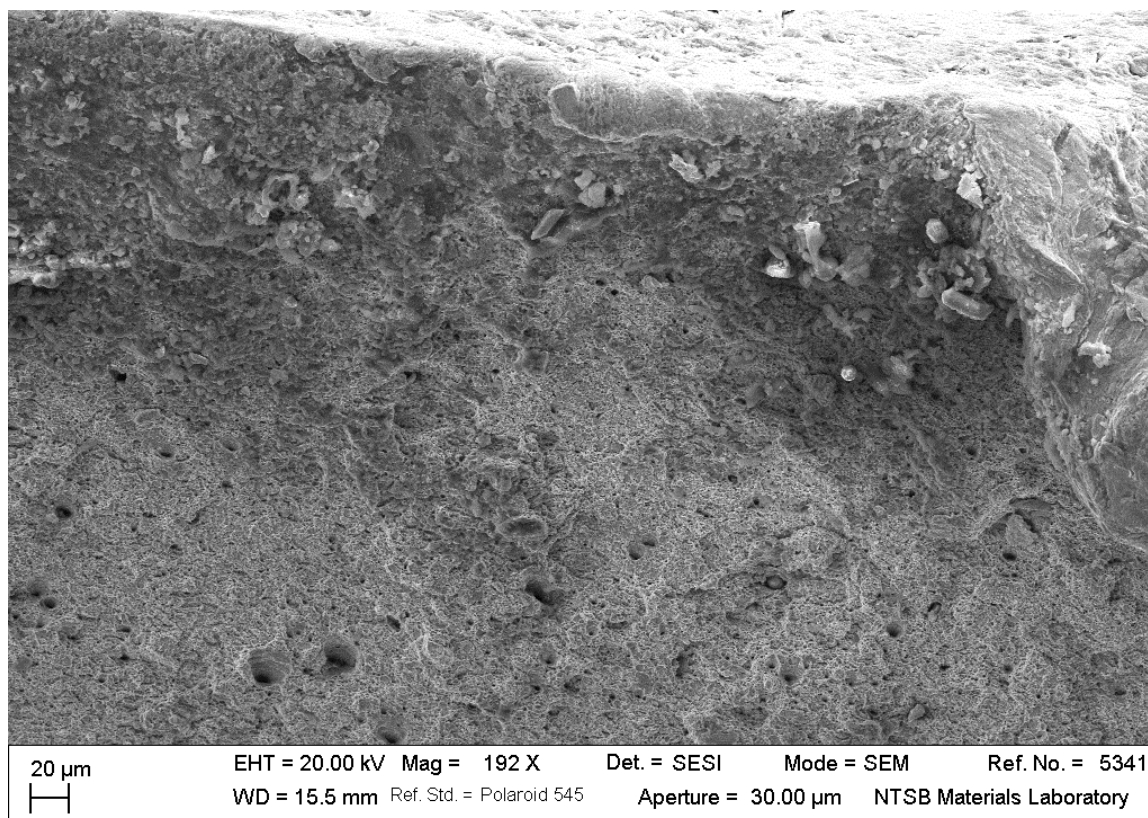


Figure 8 – Secondary electron (SE) micrograph of the outboard fracture surface, tension side.

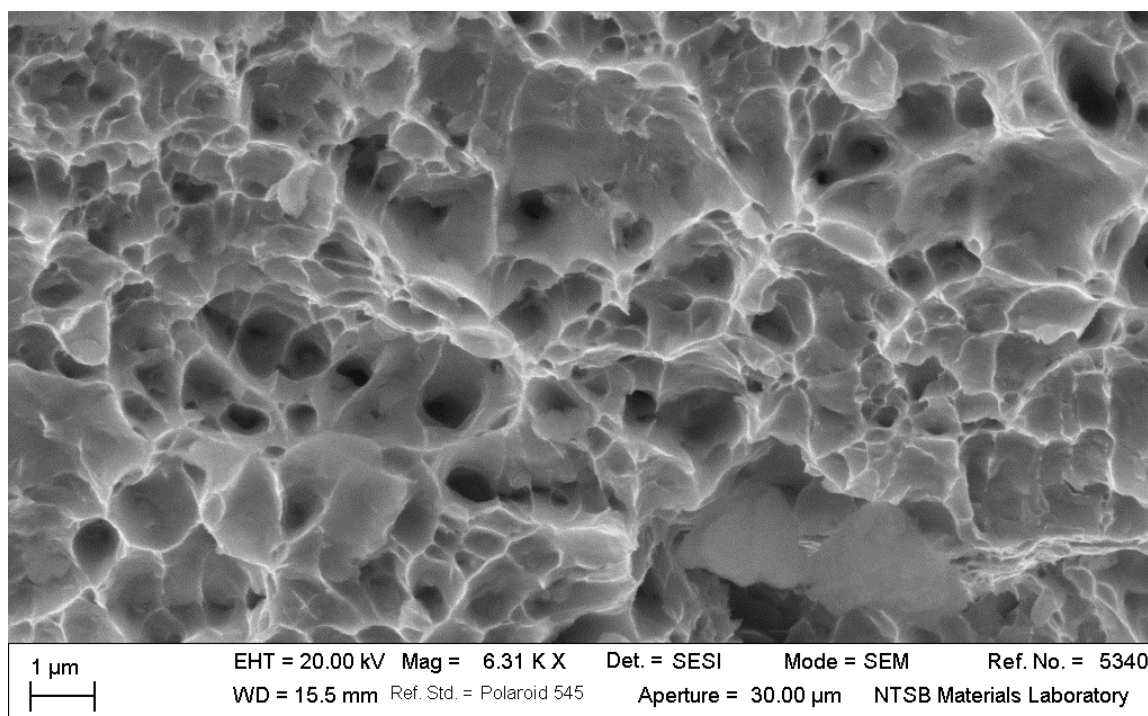


Figure 9 – SE micrograph of dimpled rupture on the tension side.

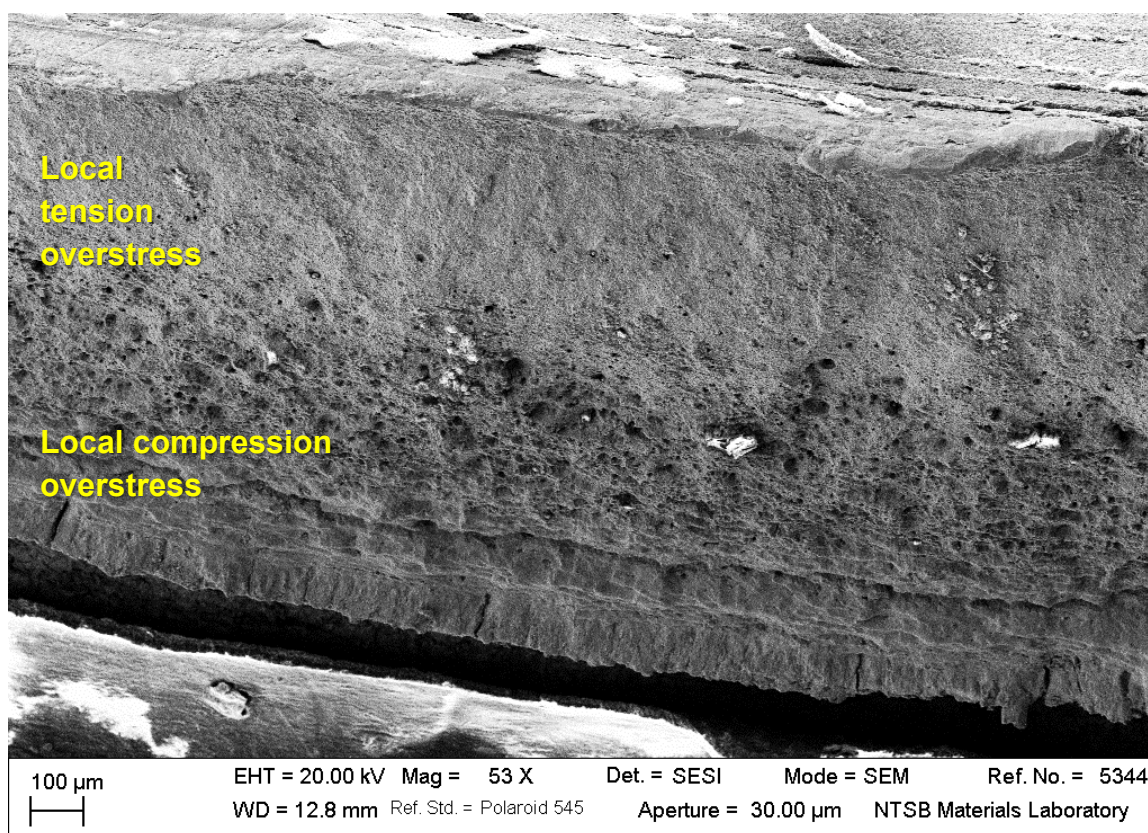


Figure 10 – SE micrograph of the compressive side of the outboard fracture surface, annotated to show the localized tensile and compressive overstress regions.

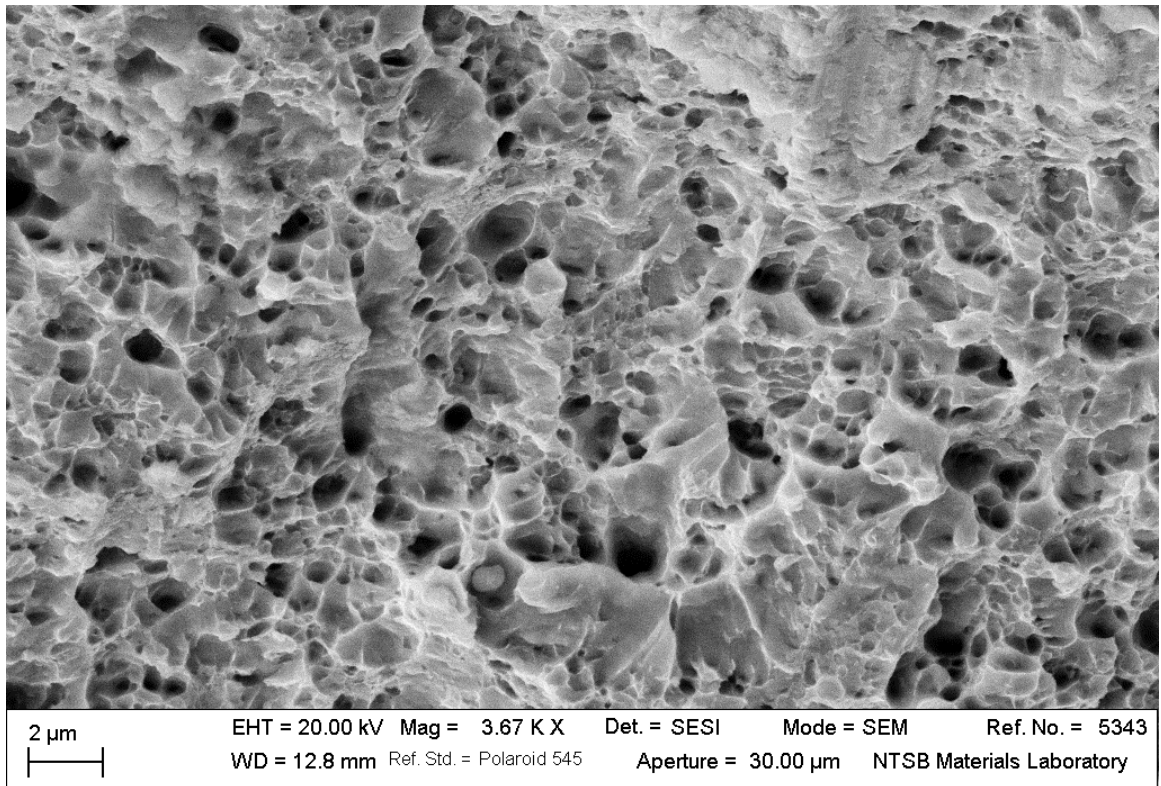


Figure 11 – SE micrograph of dimpled rupture on the tension side.

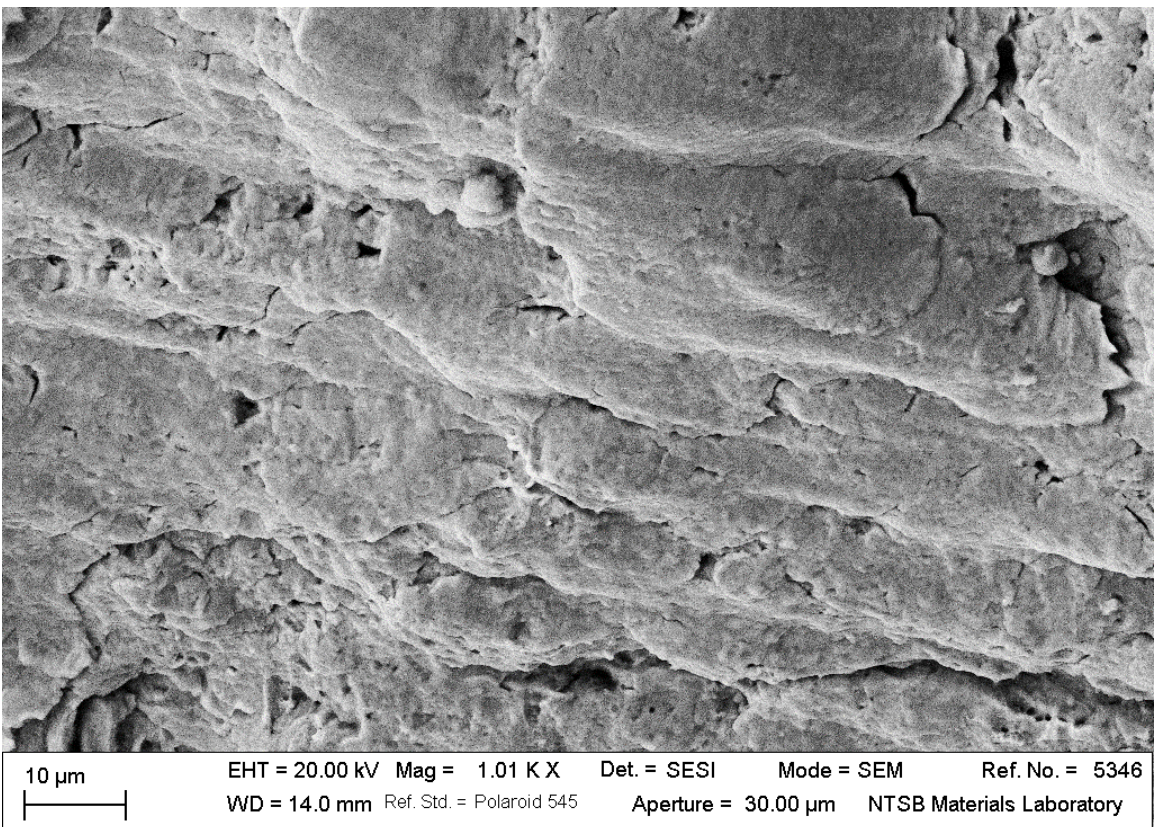


Figure 12 – SE micrograph of the outer edge of the compressive side fracture.