NATIONAL TRANSPORTATION SAFETY BOARD

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

February 5, 2015

MATERIALS LABORATORY FACTUAL REPORT Report No. 15-010

1. ACCIDENT

Place	:	Bellevue, TN
Date	:	February 3, 2014
Vehicle	:	Gulfstream 690C, N840V
NTSB No.	:	ERA14FA112
Investigator	:	Luke Schiada, AS-ERA

2. COMPONENTS EXAMINED

Section of combustion chamber case

3. DETAILS OF THE EXAMINATION

On February 3, 2014, about 1655 central standard time, a Gulfstream Commander 690C, N840V, operated by a private pilot, was destroyed when it impacted the ground near Bellevue, Tennessee, while on approach to the John C. Tune Airport (JWN) in Nashville, Tennessee. The private pilot and three passengers were fatally injured. While on final approach for landing after a missed approach, the airplane veered to the left and descended rapidly before radar contact was lost. The airplane impacted trees and the ground at about a 70° angle, consistent with being in an inverted position, and a post-crash fire consumed a majority of the airframe. Both engines were damaged from the impact and subsequent fire, but they did not display any evidence of catastrophic failure. The blades from both propellers displayed evidence of rotational scoring with leading and trailing edge gouges consistent with rotation at the time of impact.

The airplane was powered by two Executive Wings Inc. supplemental type certificate modified Garrett TPE331-5-511K (S/N P40426C), 715 horsepower engines, equipped with Hartzell three-bladed propeller assemblies.[1] Initial review of maintenance information revealed that at the time of the accident, the airframe and both engines had been operated for approximately 4460 total hours since new.

Figure 1 and Figure 2 show the combustor chamber case section, as received. The case section had been removed from the rest of the case before shipment to the NTSB Materials Laboratory. The case section exhibited indications of buckling parallel to the

[1] The TPE331 family of turboprop engines was produced by Garrett AiResearch starting in 1963. In 1968, Garrett merged with Signal Oil & Gas, which merged with Allied Corporation into AlliedSignal. AlliedSignal was acquired by Honeywell Aerospace in 1999.

circumferential direction of the case. The outboard face of the case section exhibited white residue consistent with exposure to the post-crash fire.

The case contained a longitudinal crack parallel to the engine axial direction (see Figure 3). This crack was approximately 3.75 inches in length and included a “hole-shaped” portion that was generally shinier and smoother than the adjacent fracture surface. The fracture was intentionally backcut and overstressed to separate the fracture halves. Figure 4 shows a closer view of the “hole-shaped” portion of the fracture. This region of the fracture surface exhibited radial marks directed outboard consistent with smearing damage. The case section was bowed outboard in the region. As shown in Figure 5, the case had buckled about the “hole-shaped” portion of the fracture. Discussions with the IIC and a Honeywell representative revealed that this “hole-shaped” region of the fracture corresponded with the position of a missing drain boss. This boss was welded onto the combustion chamber case.

The portions of the fracture surface outside of the “hole-shaped” region exhibited a dull luster and generally rougher surface morphology (Figure 5). One half of the fracture surface was examined using a scanning electron microscope (SEM). Figure 6 illustrates the fracture surface aft of the “hole-shaped” region. The fracture surface exhibited a cross-pattern morphology, consistent with the dendritic microstructure common to superalloy castings. Closer examination of the fracture surface revealed dimple rupture, consistent with tensile overstress failure (see Figure 7).

The area aft of the as-received fracture that was fractured in the laboratory was examined and is shown in Figure 8. Like the fracture surface in the cast portion of the case section, the laboratory fracture exhibited a dendritic morphology with dimple rupture features (see Figure 8 and Figure 9). These laboratory-produced overstress features were comparable to that of the as-received fracture surface.

The fracture surface forward of the “hole-shaped” region exhibited different macroscopic features than the aft cast portion. The fracture surface exhibited an approximately 45° slant and showed a smoother texture than the aft region. When examined in a SEM, the forward portions of the fracture surface revealed dimple rupture (see Figure 10). These fracture features were consistent with tensile overstress in a wrought superalloy material.

The fracture surface of the “hole-shaped” region was also examined in the SEM. Most of the fracture features had been obliterated by smearing. However, as illustrated in Figure 11, some features of the fracture surface were present that were consistent with elongated dimple rupture. The shape of the dimples and direction of the smearing was consistent with overstress towards the outward direction. No indications of other failure modes were observed on the fracture surface.

The chemical compositions of the wrought and cast portions of the case were inspected using energy dispersive x-ray spectroscopy (EDS) and x-ray fluorescence (XRF). The compositions of both portions were consistent with Inconel 718, a nickel-iron based superalloy.[2]

Erik Mueller
Materials Research Engineer

[2] Inconel 718 is a γ"-strengthened superalloy that can be forged or cast. This alloy is currently a trademark of Special Metals Corporation (New Hartford, NY), a subsidiary of Precision Castparts Corporation (Portland, OR).

Figure 1 – The combustor case section viewed from the outboard side, as received.

Figure 2 – The combustor case section viewed from the inboard side, as received.

Figure 3 – The combustor case fracture, as viewed from inside looking out.

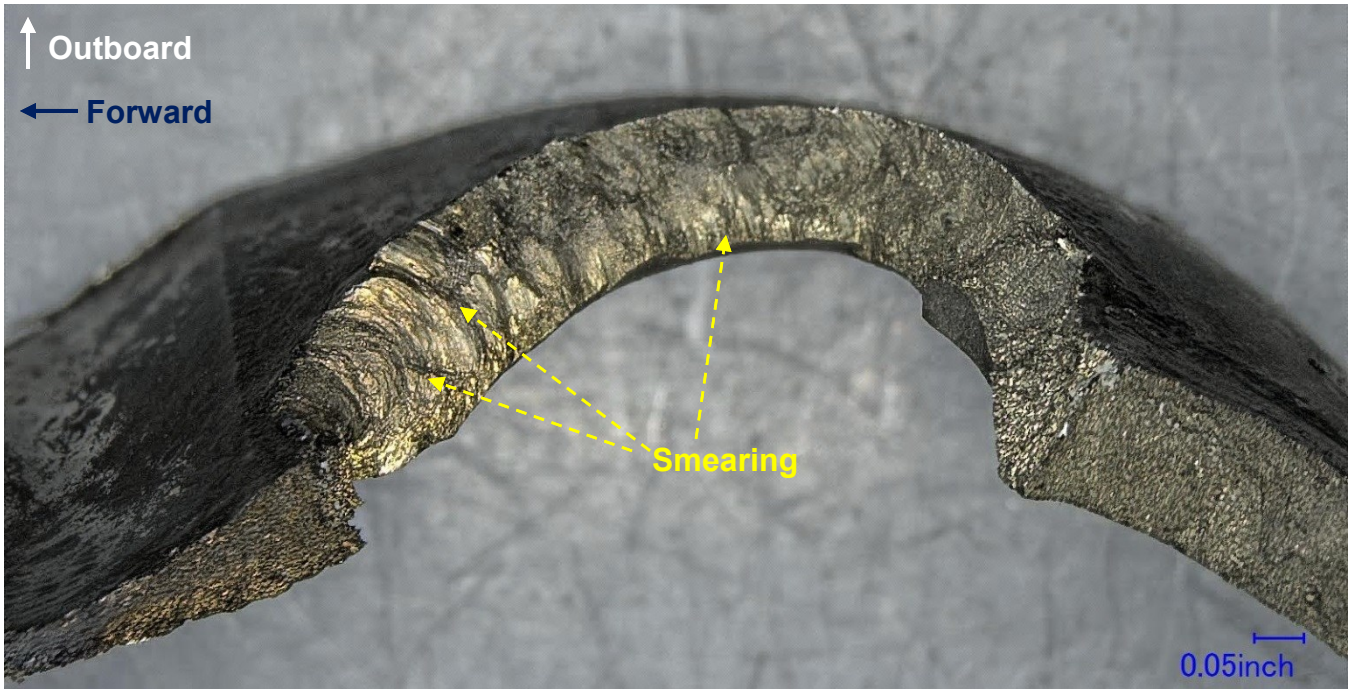

Figure 4 – The hole-shaped portion of the fracture, after backcutting and opening. The hole-shaped portion exhibited shiny, smear marks.

Figure 5 – The fracture surface of the cast portion of the case, after opening. The hole-shaped portion is on the left, which a shinier luster than the rest of the fracture.

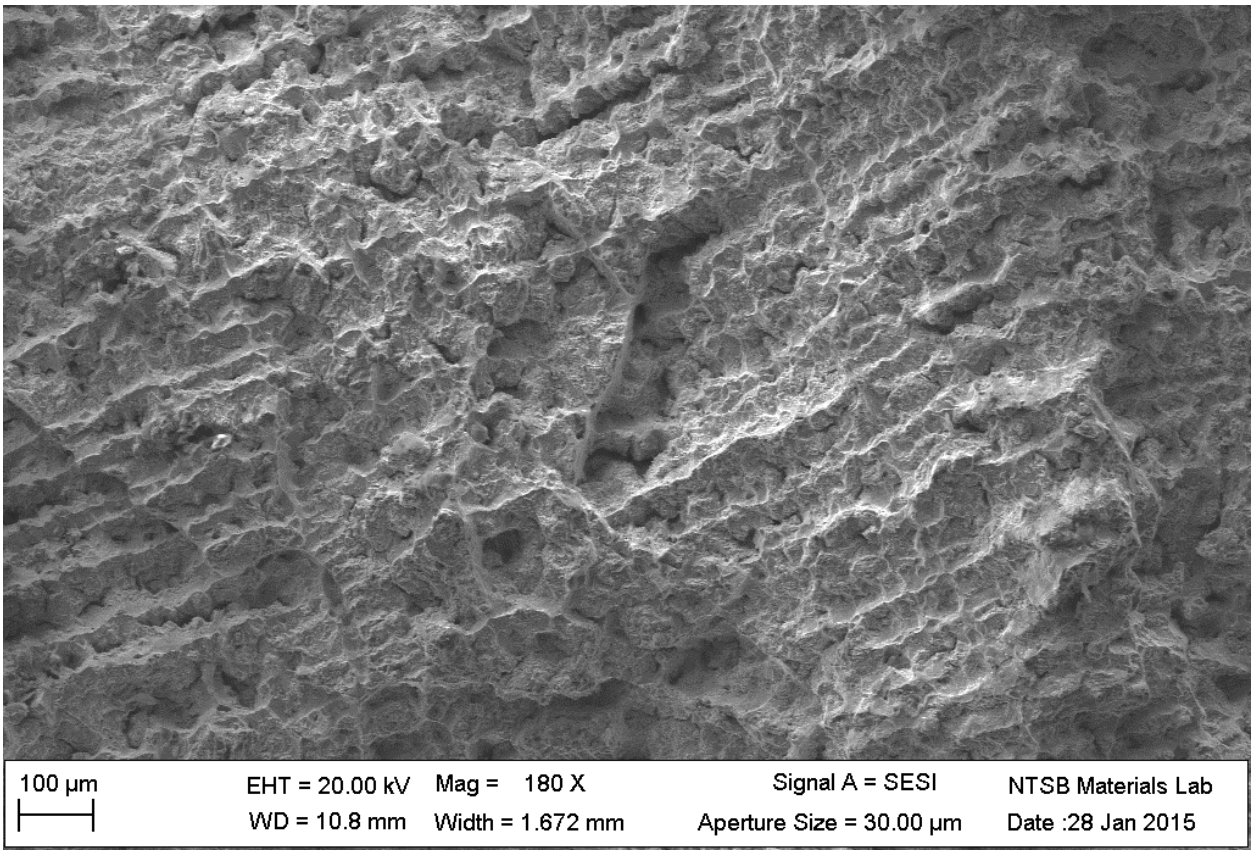

Figure 6 – Secondary electron (SE) micrograph of the fracture surface of the cast portion of the case.

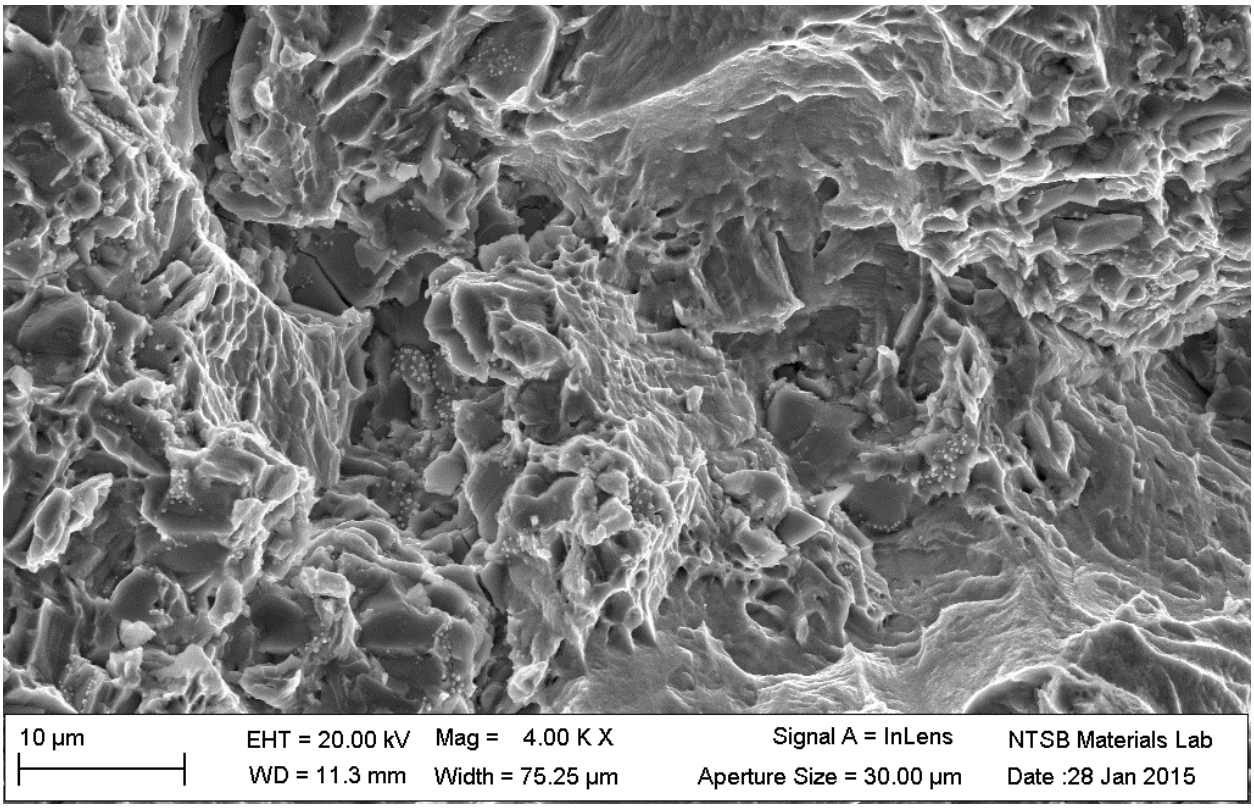

Figure 7 – SE micrograph showing the cast portion of the case fracture surface, exhibiting dimple rupture.

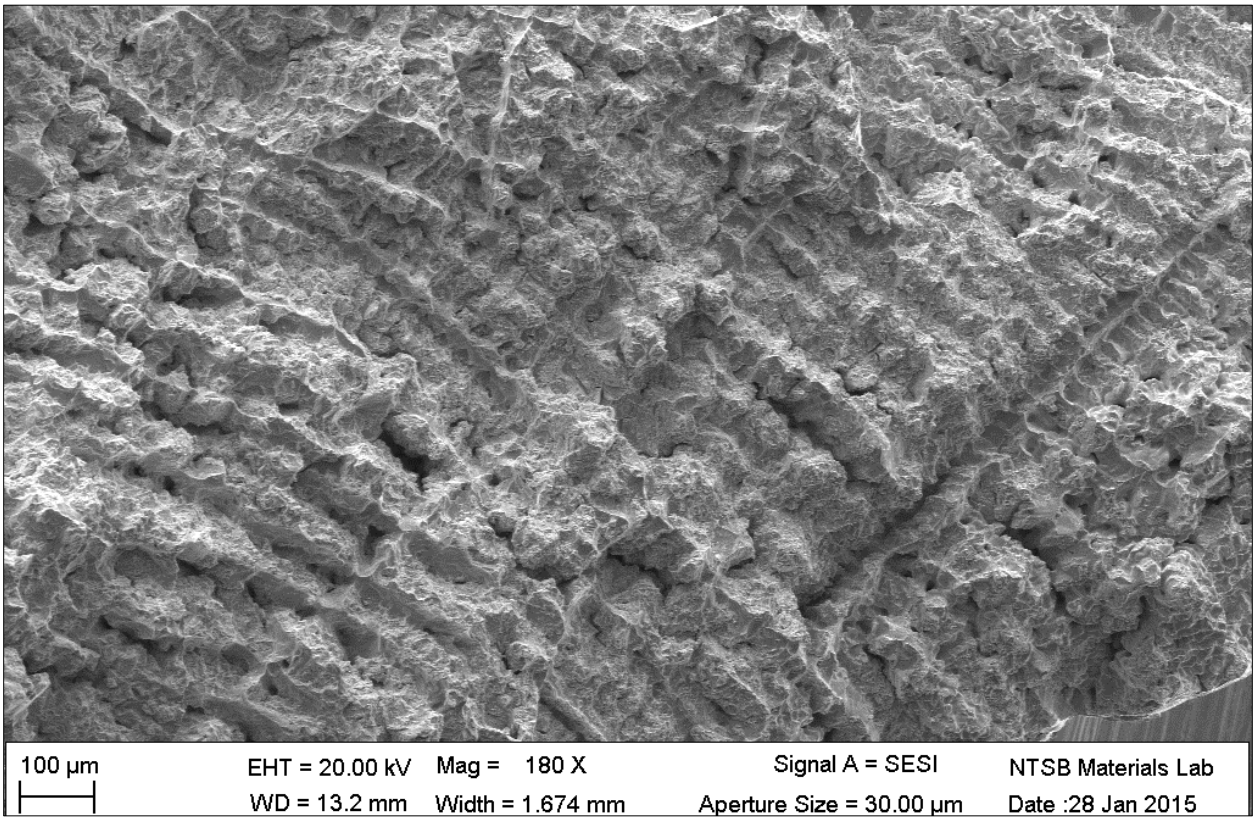

Figure 8 – SE micrograph of the intentionally overstressed region of the cast section of the case, revealing morphology consistent with the fracture surface shown in Figure 6.

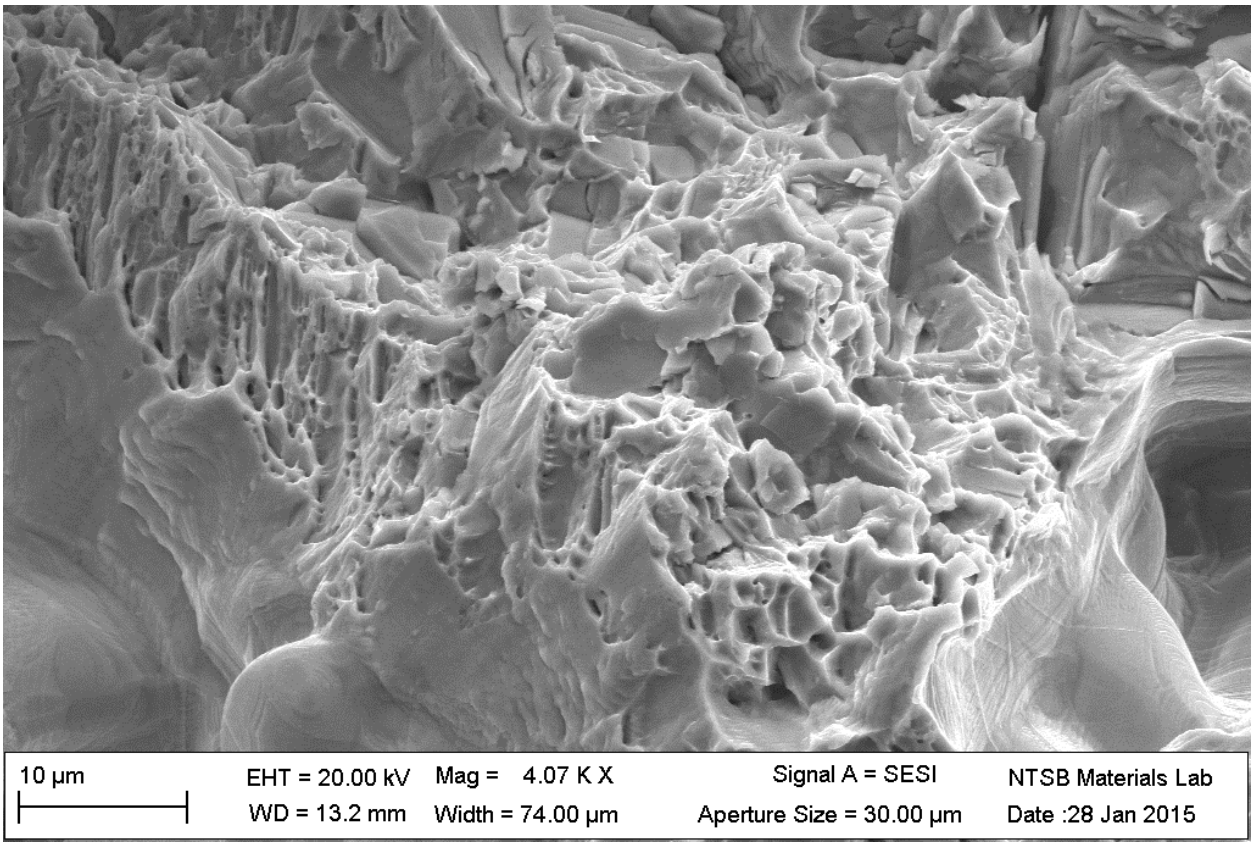

Figure 9 – SE micrograph of dimple rupture in the intentionally overstressed cast fracture surface.

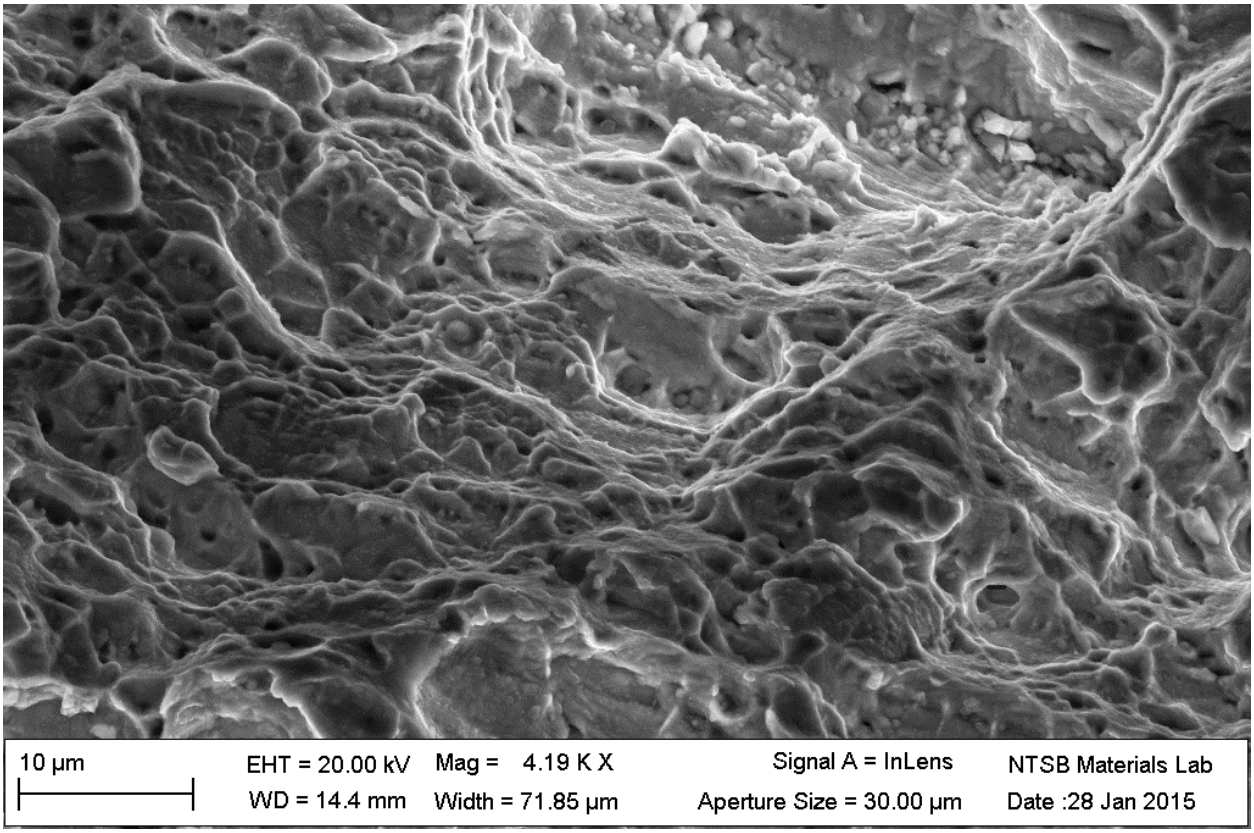

Figure 10 – SE micrograph of dimple rupture in the wrought portion of the case fracture surface.

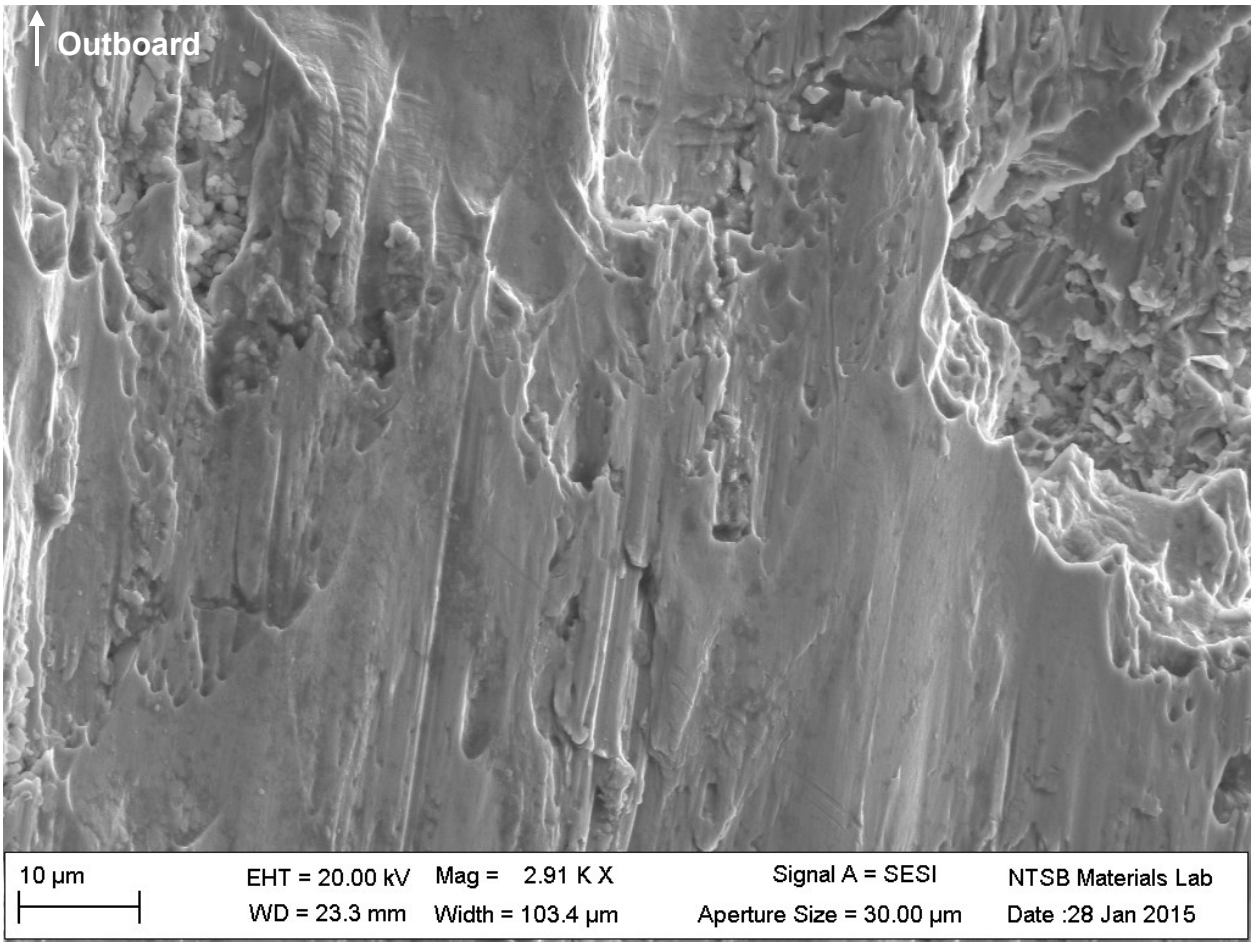

Figure 11 – SE micrograph of the hole-shaped region of the case fracture, showing smearing and elongated dimple rupture.