

# NATIONAL TRANSPORTATION SAFETY BOARD

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



November 14, 2018

## MATERIALS LABORATORY FACTUAL REPORT

Report No. 18-084

### 1. ACCIDENT INFORMATION

Place : Smethport, Pennsylvania  
Date : April 8, 2018  
Vehicle : McDonnell Douglas MD 600N, N602BP  
NTSB No. : ERA18FA122  
Investigator : Brian Rayner, AS-ERA

### 2. COMPONENTS EXAMINED

Wire cable pulley assembly  
Exemplar wire cable pulley assembly

### 3. DETAILS OF THE EXAMINATION

On April 8, 2018, about 1711 eastern daylight time, an MD Helicopter 600N was destroyed when it collided with a wooden power line support structure and terrain in Smethport, PA. The commercial pilot was seriously injured and two linemen were fatally injured. The purpose of the flight was to remove a temporarily-secured static line from the wheeled, pulley assembly (or dolly) and permanently secure the static line to poles for a power line structure. One lineman worked from the skid of the hovering helicopter, while a second lineman worked from inside the helicopter.

During the vertical descent, the tailboom and all six rotor blades separated from the helicopter. The helicopter was examined at the accident site, and all major components were accounted for at the scene. Witness marks consistent with wire contact were visible on top of the left skid forward of the front crosstube. The wreckage was recovered from the accident site to a secure facility for further examination at a later date. Examination of the structure poles and the static line revealed signatures consistent with blade strikes. One dolly was facing 180° from its operational position. The dolly was recovered from the top of the structure, and examination revealed it was intact except for the locking gate, which had fractured. This dolly and an exemplar dolly were sent to the NTSB Materials Laboratory for further examination.

Figures 1 through 4 illustrate the exemplar pulley assembly, or dolly, as received. The assembly consisted of a circular pulley wheel with a U-shape groove for holding a cable, surrounded by a block with a locking gate (Figure 2). This locking gate latch was

spring loaded to stay in the closed position against a tab on the block when not being actuated (Figure 3). In this position resting against the tab, the latch would be under a bending force, with the tension side being on the outward face (upward, facing the reader in Figure 3), with the compression side facing inward.

As demonstrated in Figure 4, when actuated by pushing inward, the locking gate latch would rotate inward to allow a cable to be moved inward or outward. In the closed position, the latch would prevent the cable from leaving the groove on the pulley wheel.

Figure 5 shows the accident pulley assembly, as received. Rope was tied around one of the pulley wheel spokes and the block arms to prevent rotation of the pulley wheel. The markings on a block arm stated "slingco®", "Model Number: ZAB6651", and "Working Load 6,000 lb (3:1)".

Of note was the locking gate latch that had fractured, shown in Figure 6. The fracture was oriented at a general 45° angle. The gate had fractured in a manner such that two separate fragments of the latch remained affixed to the attachment bolt.

Figure 7 shows a view of the block arm with the tab that held the locking gate. As annotated in the figure, there were several witness marks present consistent with rubbing or gouging from contact with a metallic part. This was most exemplified in the pulley wheel guide outer corners. Each corner exhibited smearing of material in the outward (upward in Figure 7) direction. This smearing orientation was consistent with a part moving outward and sliding against the guide corners.

In addition, the block tab exhibited smearing marks oriented in an outward direction, consistent with a part moving outward and sliding against the tab. On the upper flat face of the block arm were two scrape marks, highlighted in Figure 7. The marks exhibited material being pushed outward, consistent with contact from a part moving outward.

Figure 8 shows the remnants of the latch after disassembly of the restraining bolt that held the locking gate in place. As shown in Figure 8, the only remnants remaining were the clevis portions. Figure 8b shows the fracture surfaces of the latch remnants, using oblique lighting to shadow and enhance the fracture features. Figure 9 and Figure 10 show closer views of the two fracture surfaces. Both fracture surfaces exhibited chevron marks and river patterns, consistent with overstress fracture.

Figure 9 shows the smaller latch fragment fracture surface. As annotated in the figure, the general direction of the fracture features was from the outward to inward in an angled direction. One side exhibited a large shear lip that faced the reader. These features were consistent with fracture from overstress in a bending direction. The five features on the opposite edge of the shear lip were consistent with smearing marks from the top to the bottom of the figure. These smearing marks were consistent with subsequent impact or rubbing damage to the fracture surface after the latch had fractured.

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Figure 10 shows the larger L-shaped latch fracture surface. The river patterns and chevron marks were consistent with having emanated from an outward edge toward the inward side, as annotated in the figure. The opposite side exhibited a small shear lip, which faced the reader in the figure. These features were consistent with fracture from overstress in bending, with the tension side located on the outward face of the latch. No particular features were observed at the fracture origination consistent with a pre-existing defect such as a crack, pore, or inclusion (see Figure 11).

The fracture surfaces were examined using a scanning electron microscope (SEM). Figure 12 shows a typical area of the fracture surface. There were solidification voids sporadically located on the fracture surfaces, but they were typically less than 100  $\mu\text{m}$  in size. The fracture surface exhibited some lamellar-oriented features, particularly at lower magnification. Closer examination, as shown in Figure 13 and 14 show dimple rupture features, consistent with overstress fracture. The clustering of the dimple rupture features was consistent with those typically observed in casting fractures.

Areas of the fracture surface near the start of the fracture (edge) exhibited a generally flatter surface roughness (see Figure 15). However, closer examination of these areas revealed dimple rupture in shear orientations as well as material tearing, illustrated in Figure 16. No features consistent with other fracture modes were observed on the fracture surfaces.

A section of the fractured gate near the fracture surface was mounted and polished. Figure 17 shows a typical area of the gate microstructure, which exhibited a dendritic morphology consistent with a cast material. The chemical composition of the gate was inspected using energy dispersive x-ray spectroscopy (EDS). The composition was consistent with an AA 400-series aluminum casting alloy. The electrical conductivity and hardness were inspected per ASTM E1004 and ASTM E18, respectively.<sup>1,2</sup> The conductivity averaged 31.0% IACS, and the hardness averaged 68 HRE.<sup>3</sup> These data were consistent with those typical of this alloy in the as fabricated condition.

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<sup>1</sup> ASTM E1004 – *Standard Test Method for Determining Electrical Conductivity Using the Electromagnetic (Eddy-Current) Method*. ASTM International, West Conshohocken, PA

<sup>2</sup> ASTM E18 – *Standard Test Methods for Rockwell Hardness and Rockwell Superficial Hardness of Metallic Materials*. ASTM International, West Conshohocken, PA.

<sup>3</sup> HRE – Hardness, Rockwell E scale. An indentation method of determining the hardness of softer cast alloys using a 1/8-inch diameter ball indenter and 100 kg load.

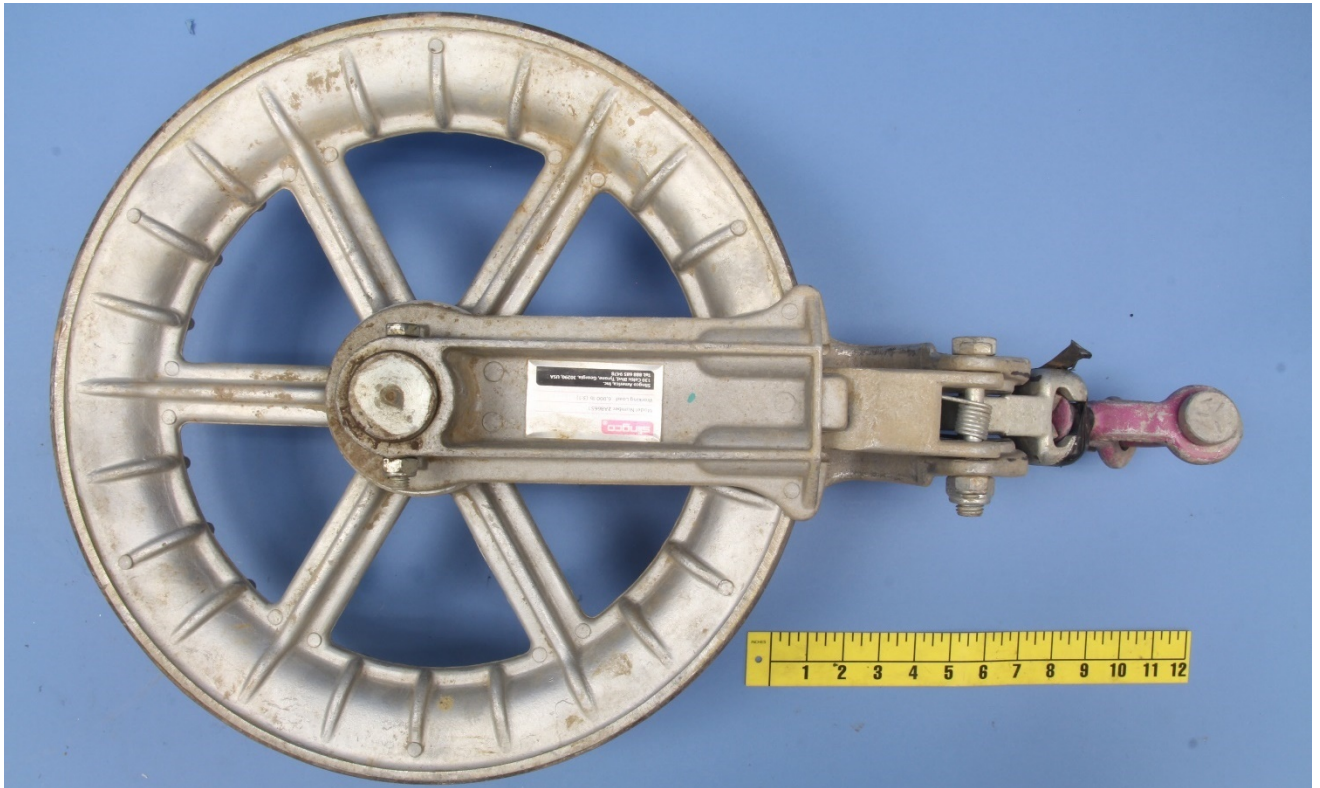


Figure 1 – The exemplar pulley assembly, as received.

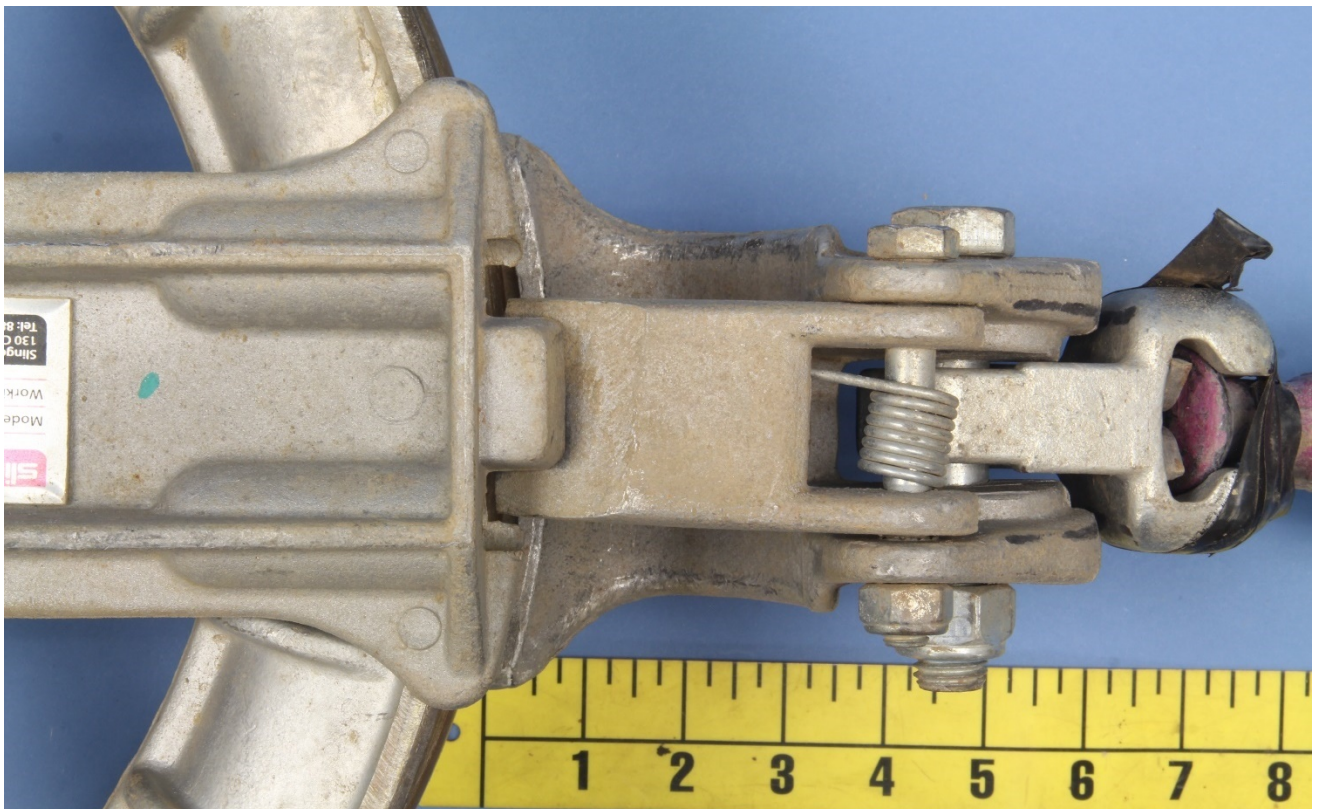


Figure 2 – The locking gate of the exemplar pulley assembly, shown as received.



Figure 3 – The locking gate from Figure 2, shown from the side in the latch closed position.



Figure 4 – The locking gate from Figure 2, shown from the side in the latch open position.

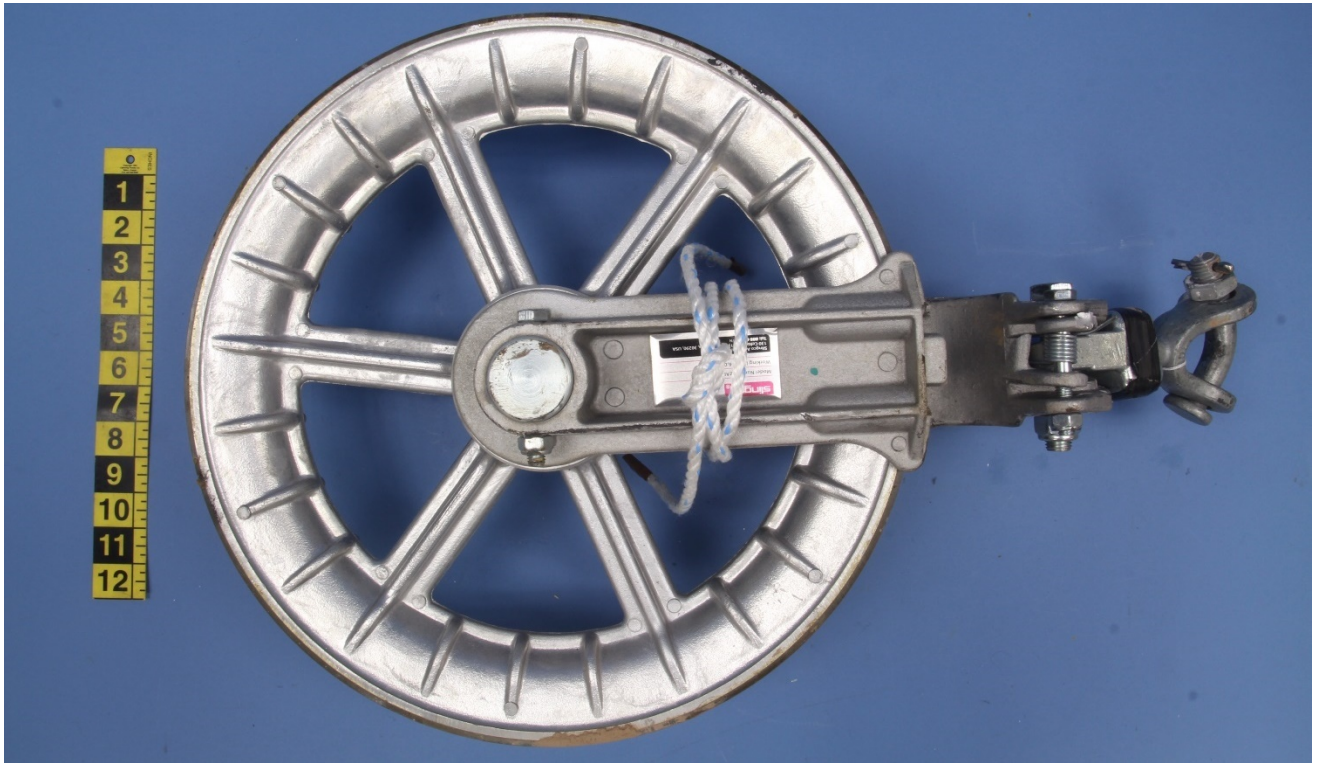


Figure 5 – The accident pulley assembly, as received.

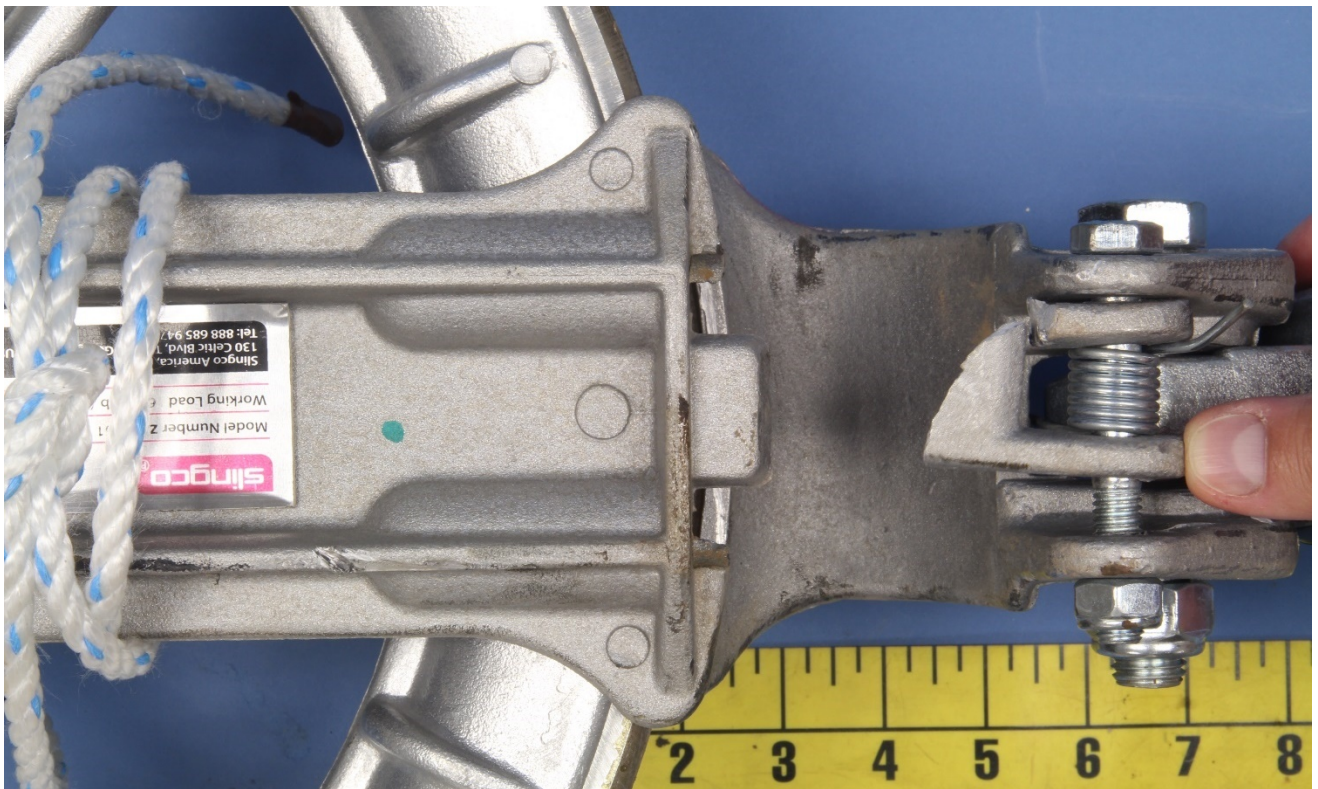


Figure 6 – The locking gate part of the accident pulley assembly, as received and oriented to show the fractured latch as it would be arranged in the closed position.

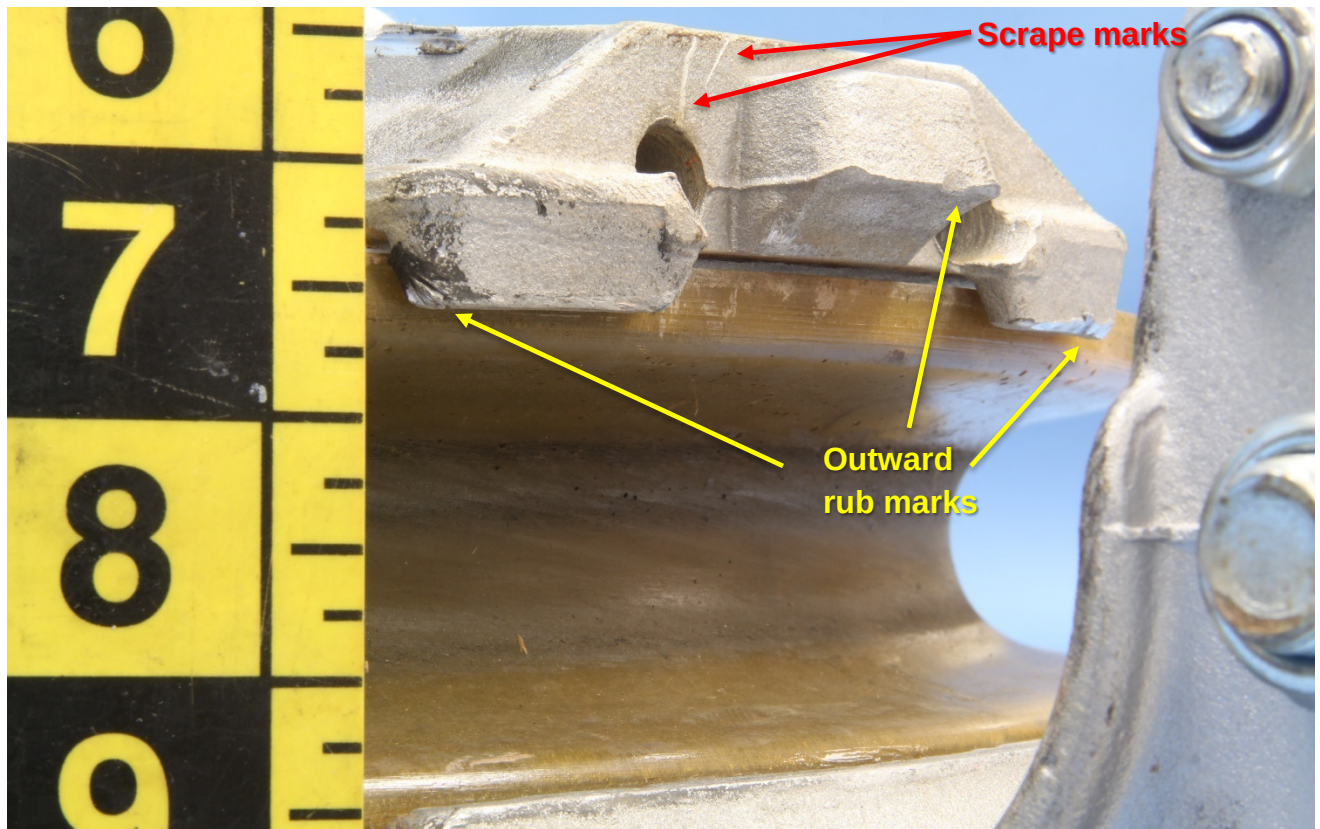


Figure 7 – A view of the tabs for the locking gate from the accident dolly block arm, viewed from the side and below. Witness marks are labeled on the tabs and surface.

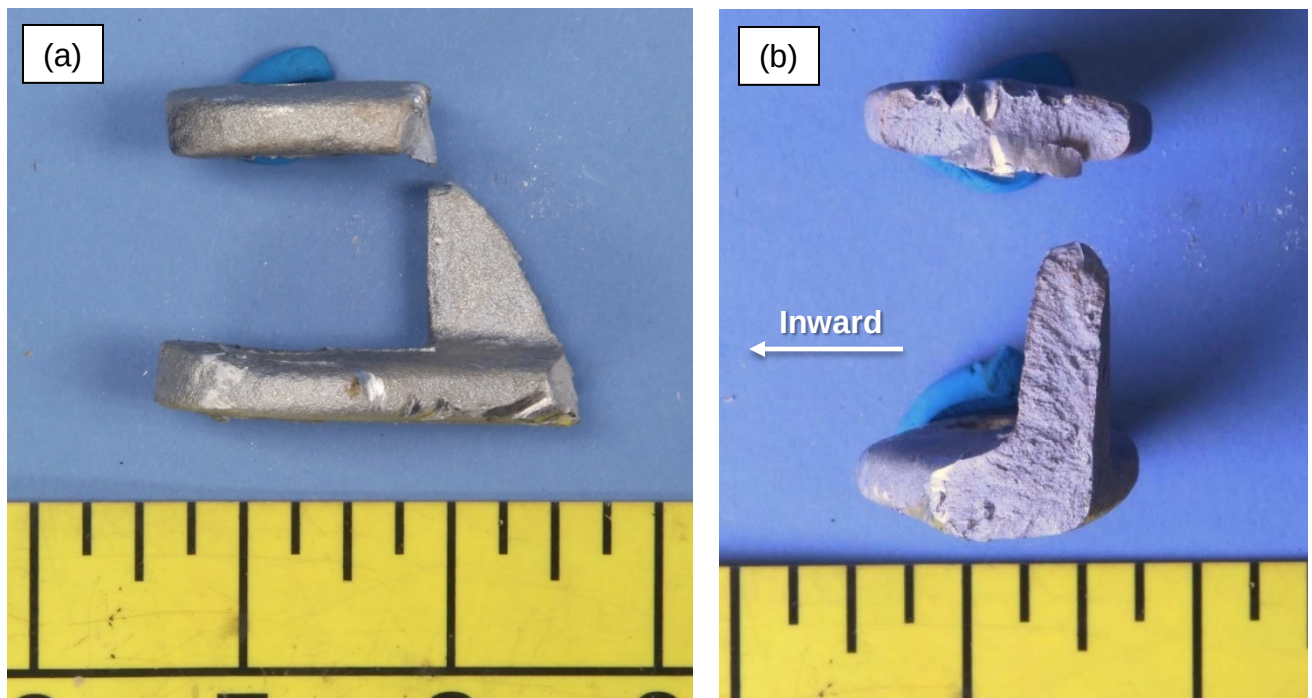


Figure 8 – The fractured latch pieces, after disassembly from the dolly viewed (a) from the side and (b) from the fracture surfaces with oblique lighting to highlight features.

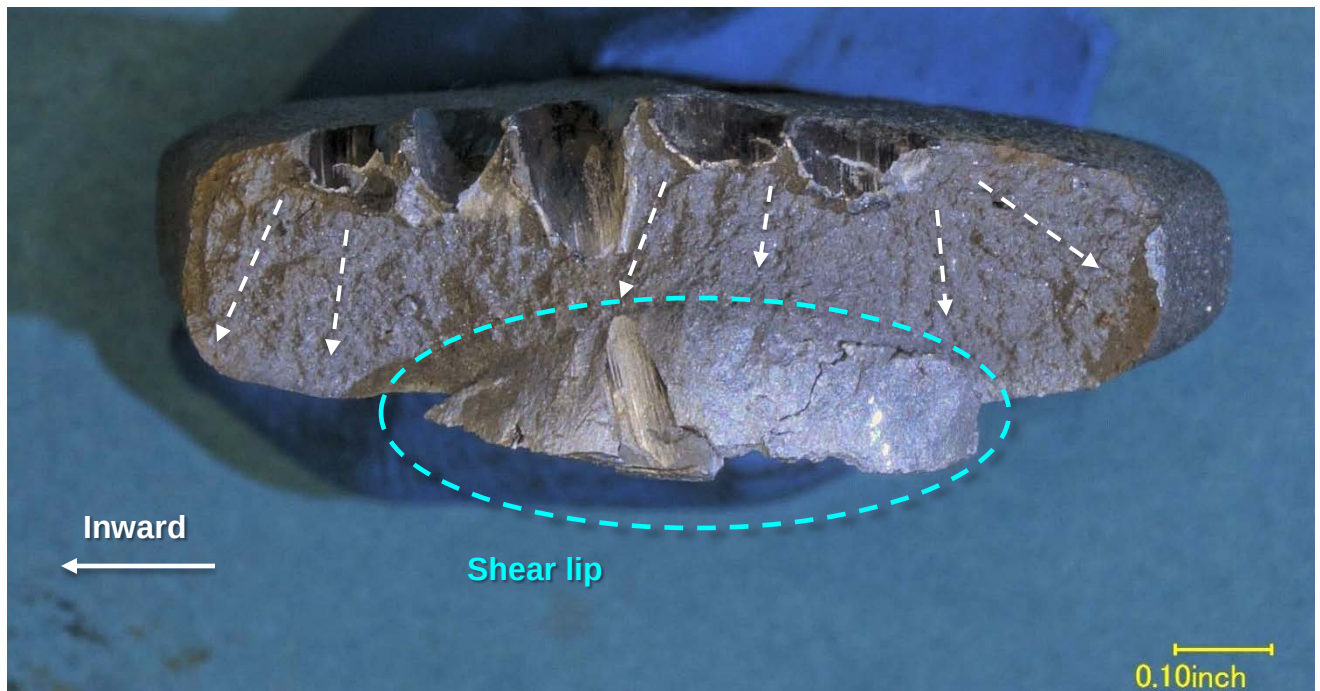


Figure 9 – The smaller latch fragment fracture surface, under oblique lighting.

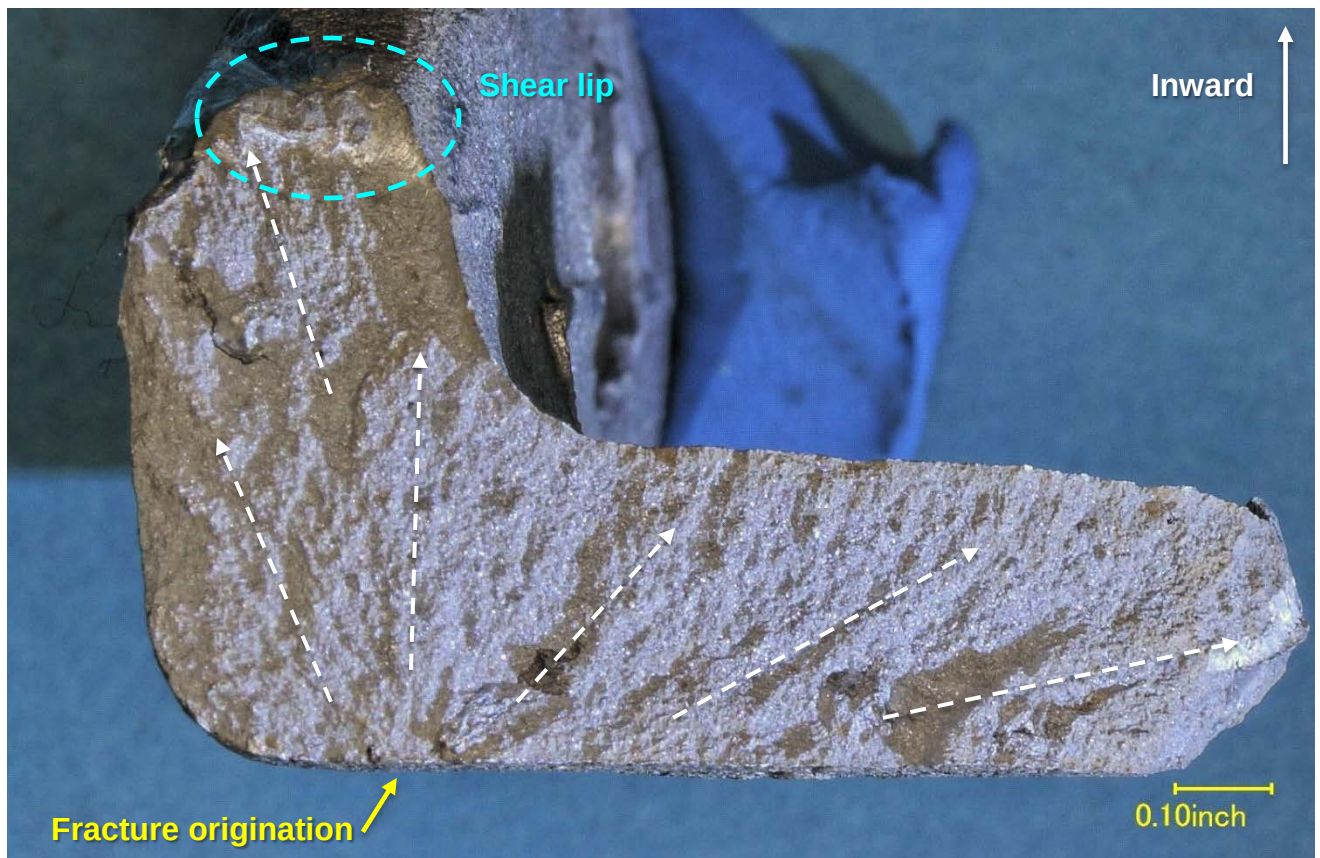


Figure 10 – The larger L-shaped latch fragment fracture surface, under oblique lighting. Arrows indicate the fracture direction and fracture origination.

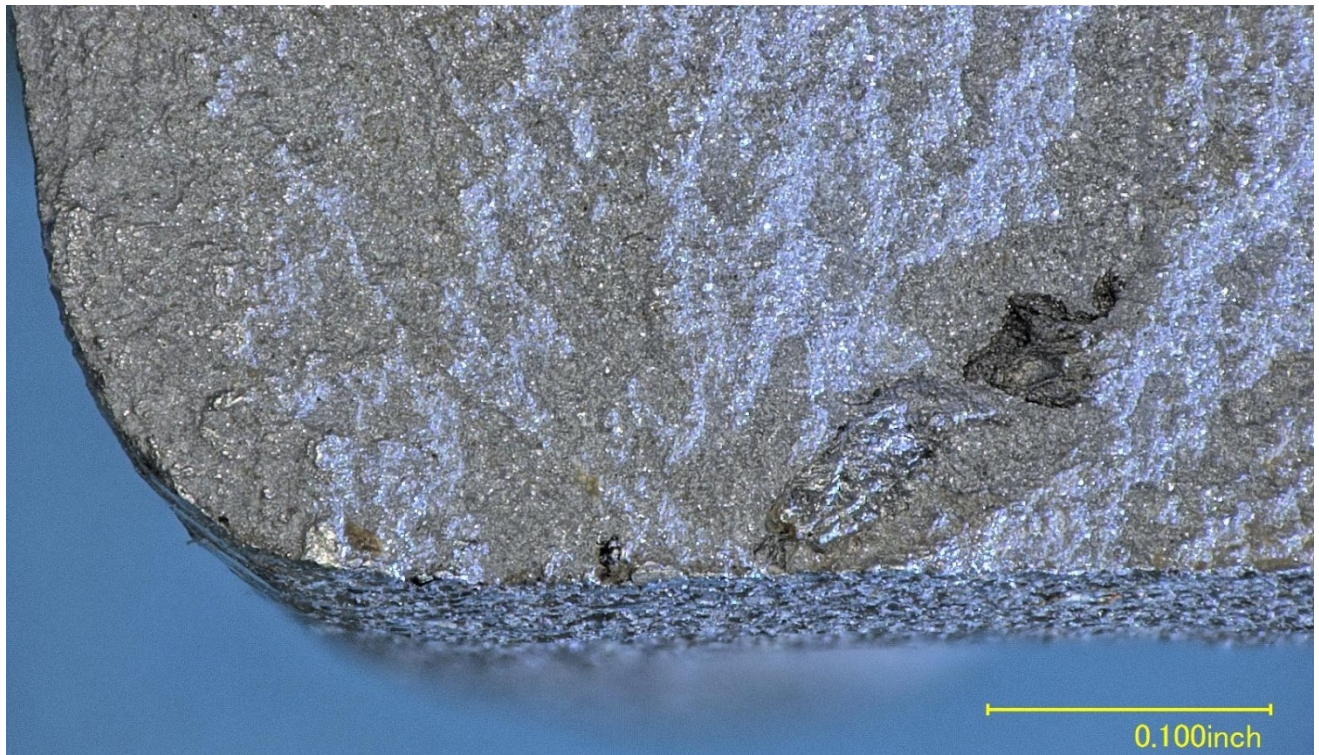


Figure 11 – Closer view of the fracture origination site, under oblique lighting.

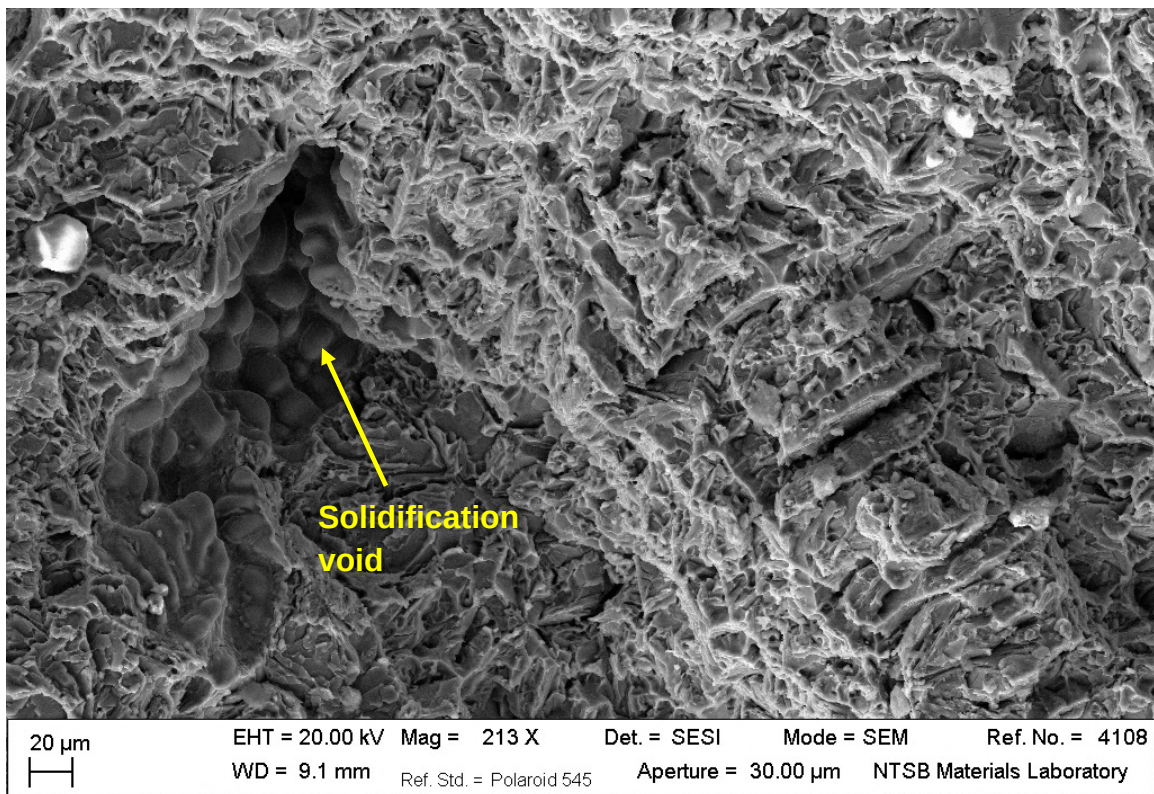


Figure 12 – Secondary electron (SE) micrograph of a typical area of the latch fracture surface.

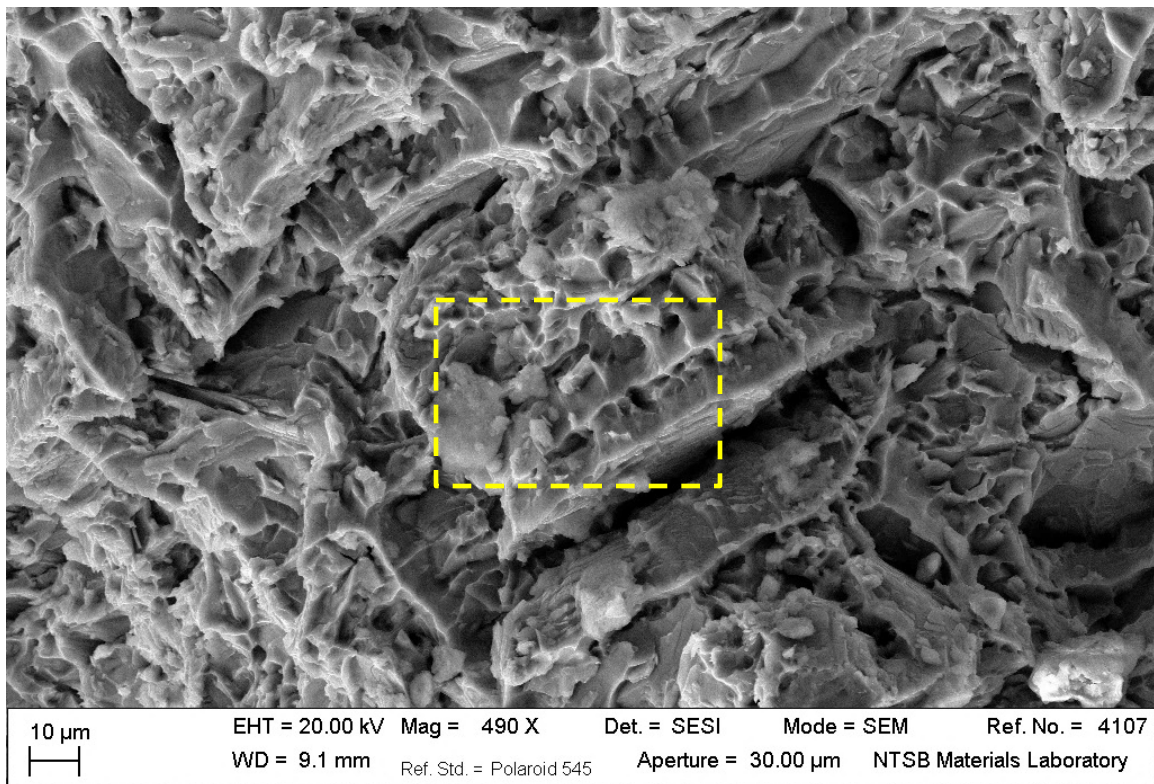


Figure 13 – SE micrograph of lamellar areas of the latch fracture surface. The boxed area is shown in Figure 14.

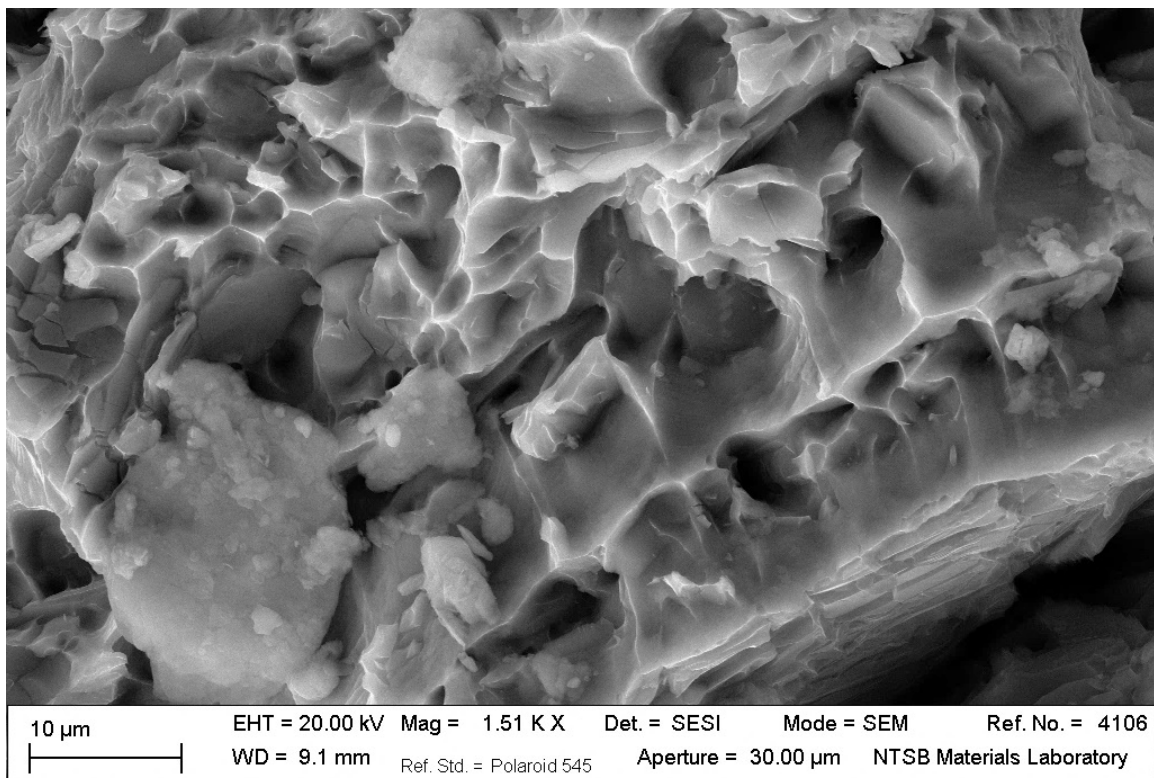


Figure 14 – SE micrograph of the boxed area in Figure 13, showing dimple rupture.

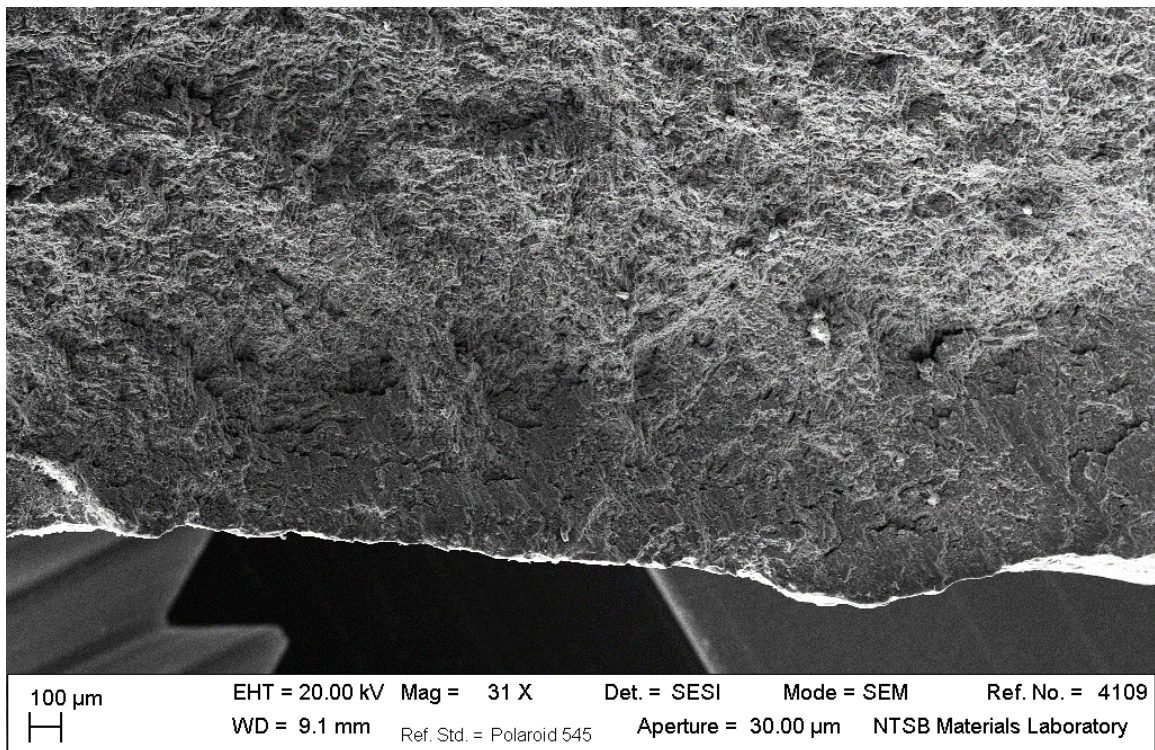


Figure 15 – SE micrograph of an edge of the latch fracture surface.

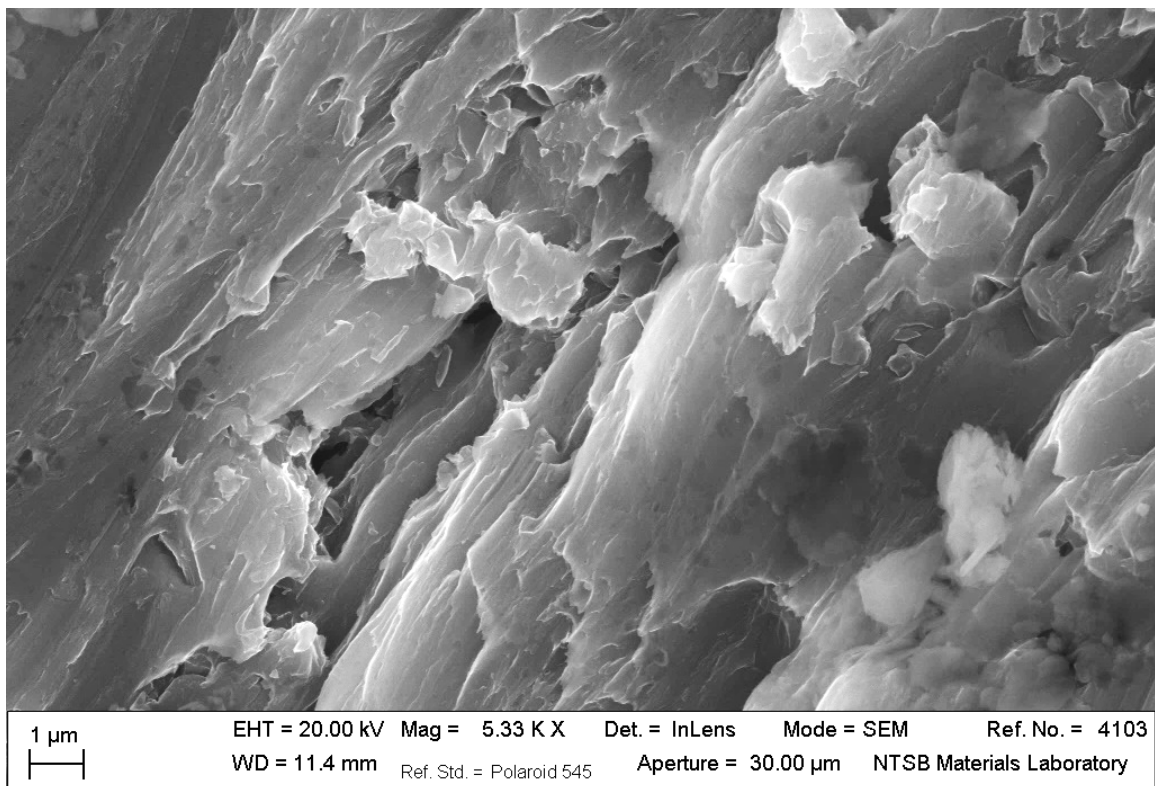


Figure 16 – SE micrograph showing tearing and dimple rupture on the flat area near the edge of Figure 15.

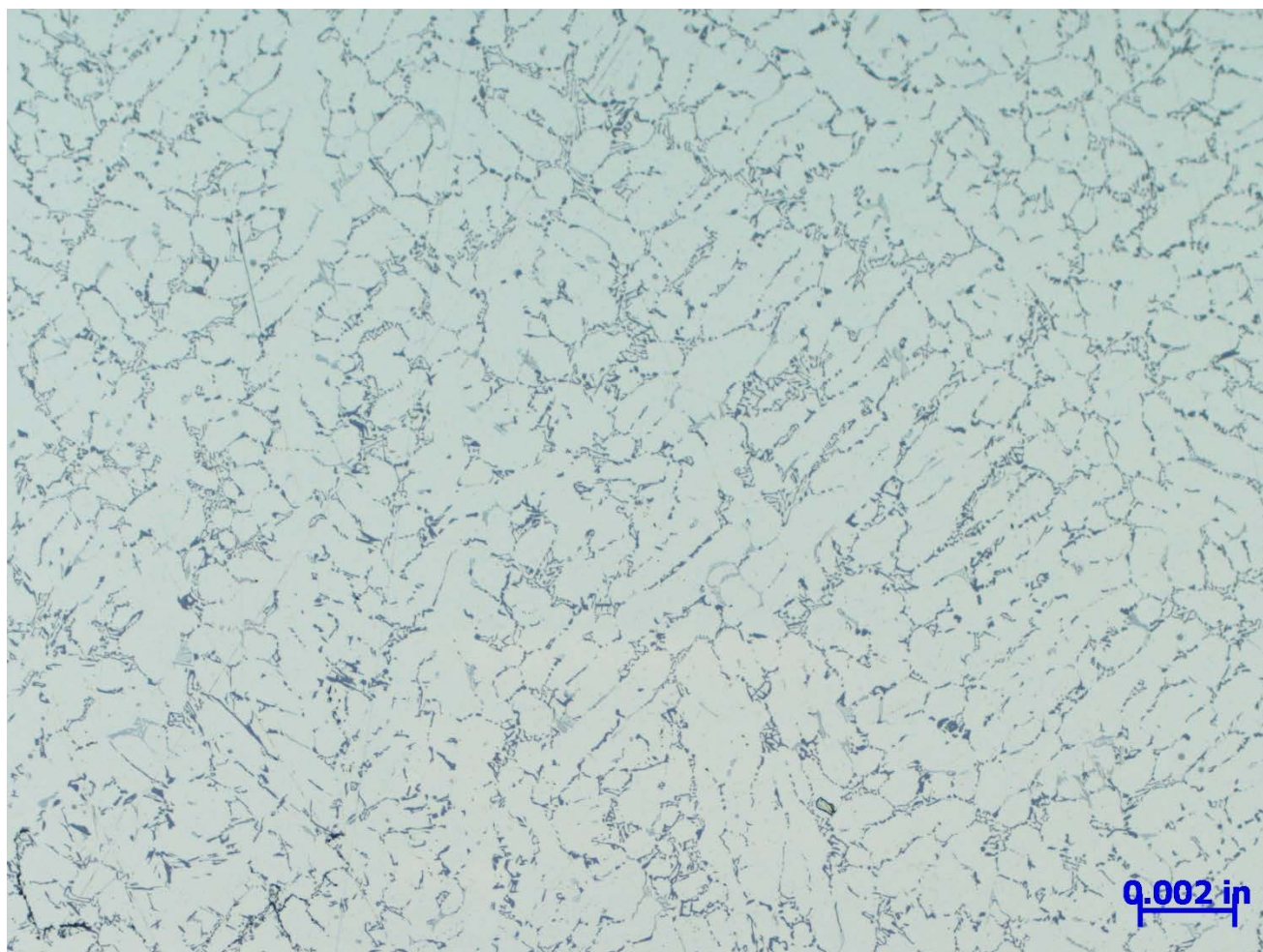


Figure 17 – Bright field (BF) micrograph of a typical area of the latch microstructure (~200X, as polished).