NATIONAL TRANSPORTATION SAFETY BOARD

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

August 27, 2012

MATERIALS LABORATORY FACTUAL REPORT | Report No. 12-088

A. ACCIDENT INFORMATION

Place	:	Kenai, Alaska
Date	:	July 14, 2012
Vehicle	:	Piper PA-18-180, N7154Z
NTSB No.	:	ANC12LA075
Investigator	:	Clinton O. Johnson, AS-ANC

B. COMPONENTS EXAMINED

McCauley Propeller Blade section Design No. DES1A175

C. DETAILS OF THE EXAMINATION

The flat side of the as-received section of propeller blade is displayed in the upper view of figure 1. The blade portion was from the leading edge to the trailing edge in the chordwise direction and about 3 inches long spanwise. The blade piece had a chordwise saw cut on the inboard edge and a chordwise fracture at the outboard edge. The fracture was reportedly about 7 inches from the blade tip. The tip portion of the blade was not recovered.

The fracture was separated into two lengths by a semi-circular hole located at about 1/3 of the chord from the trailing edge as shown in figure 1. Magnified examinations of the fracture face revealed relatively flat fracture with features consistent with fatigue progression through aluminum alloys. The fatigue features were present on either side of the hole and totally covered the fracture portion on the trailing edge side of the hole. In total, the fatigue features were visible covering about 60% of the total blade cross section. The remaining fracture had a textured matte gray surface consistent with overstress separation. The fatigue terminus is indicated by the dashed yellow line in the upper view of figure 2.

Closer examinations including scanning electron microscope (SEM) viewing revealed fracture traces indicating fatigue initiation in the vicinity of the corners formed by the intersection of the hole and the flat side of the blade (see arrows in central view of figure 2). On the trailing edge fracture, fatigue striations were found very close the corner (lower left view) while post fracture damage destroyed the origin area on the fracture segment on the leading edge side of the hole (lower right view of figure 2).

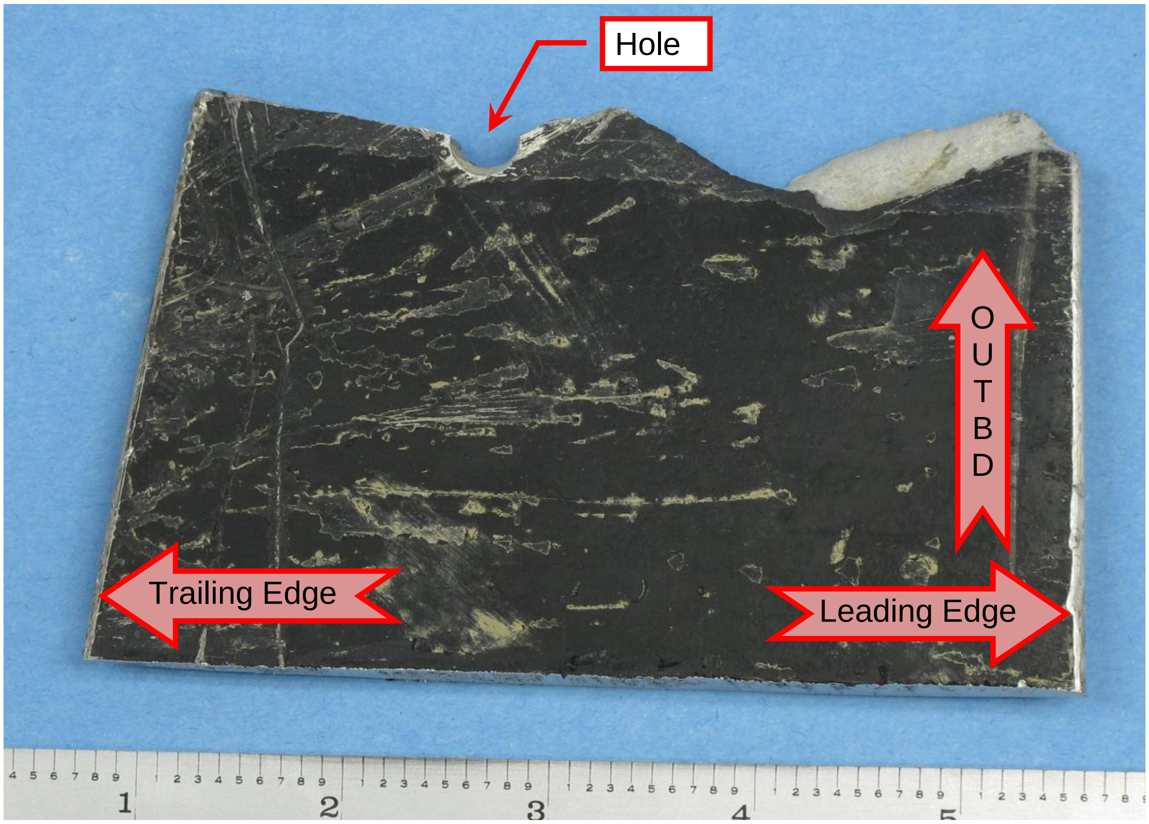
Inspections found the hole to be nearly cylindrical with an approximate 0.3 inch diameter oriented about 20º from perpendicular to the flat side of the blade. The surface of the hole had an undulating, flowing appearance with no visible fracture features, as shown in the views of figure 3. In addition, the edges of the hole were partially beveled as if a chamfer were machined into the existing hole.

During SEM examinations deposits were found on portions of the hole surface as shown in the upper view of figure 4. Energy dispersive x-ray spectroscopy (EDS) of the deposits established that they were predominately lead with oxygen and carbon and traces of iron and manganese. The spectrum in the lower part of figure 4 shows the identified peaks along with elements from the underlying base metal, aluminum, copper and magnesium. The upper view of figure 5 is a higher magnification view of the deposits with a clear area of the base metal showing. The lower view is the same area with a spectral map showing the distribution of lead (red dots) and aluminum (blue dots) overlaid.

As-received, both sides of the blade section were painted black. The paint was readily removed during ultrasonic cleaning of the blade in an acetone bath. The removed paint revealed shiny surface markings and abrasion patterns on both the camber and flat sides of the blade consistent with local abrasive reworking around the holes, as shown in figure 6. The flat side had heavy deep scratches in addition to a finely sanded ring around the hole. The unabraded surfaces of the blade had a dull greenish grey appearance consistent with an anodized surface with remnants of green primer paint.

Closer viewing of the camber side revealed two areas where a white opaque plastic-like material filled void regions around the hole as shown in the upper view of figure 7. Optically the material had highly reflective regions dispersed throughout, as shown in the lower left view of figure 7. SEM examinations revealed a somewhat nonconductive matrix material with randomly dispersed spherical beads as shown in the upper view of figure 8. EDS spectra of the beads showed major peaks for silicon, oxygen and sodium and minor peaks for calcium and magnesium, consistent with soda-lime glass. EDS of the matrix material showed large peaks for silicon, magnesium and oxygen along with minor peaks for aluminum and sulfur. All areas of the material gave a significant carbon peak. The lower view of figure 8 show an EDS spectrum for the bulk material including both the beads and the matrix.

Joe Epperson
Senior Metallurgist



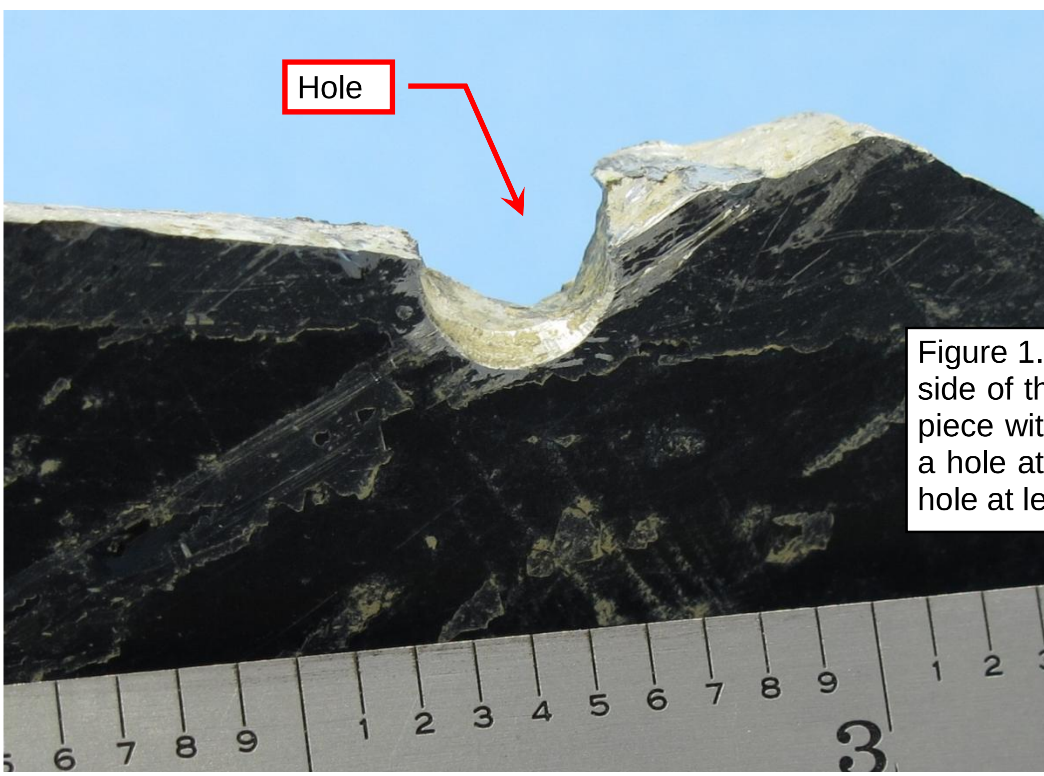


Figure 1. Overall view of the flat side of the as-received propeller piece with fracture separated by a hole at top. Closer view of the hole at left.

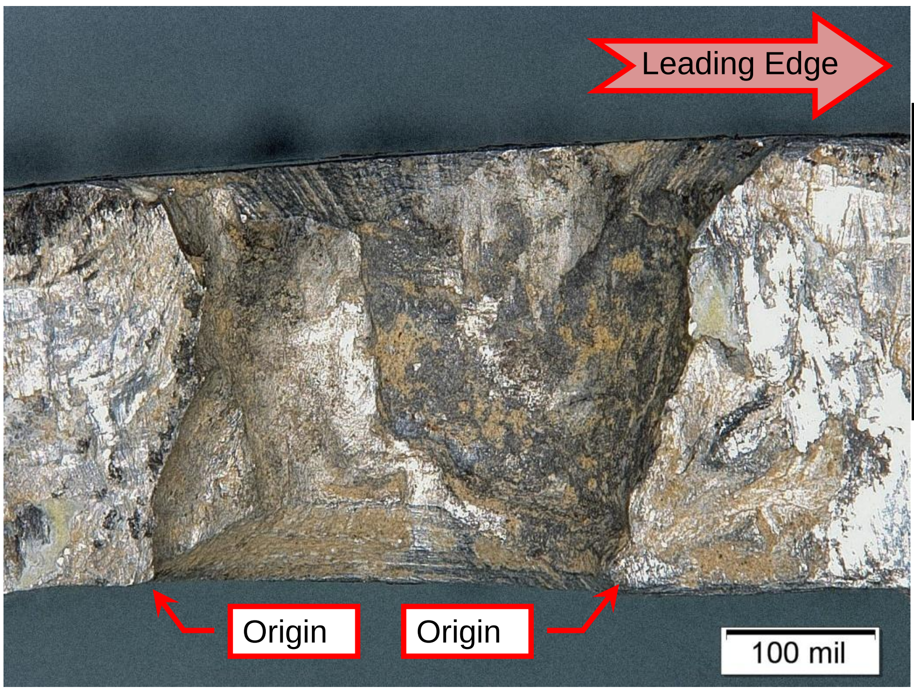
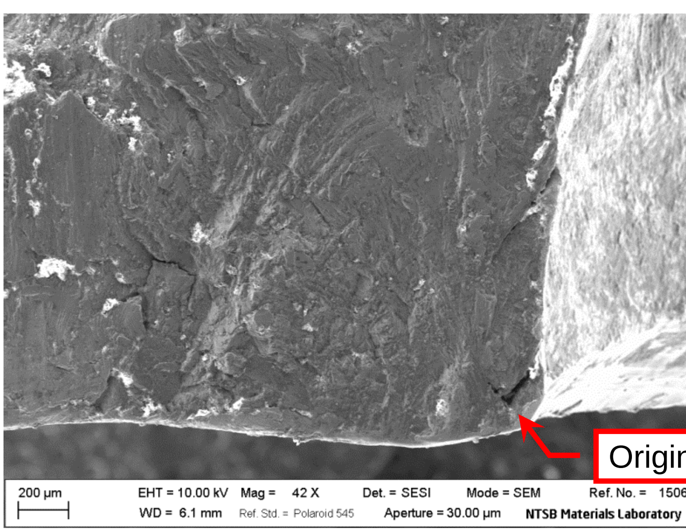
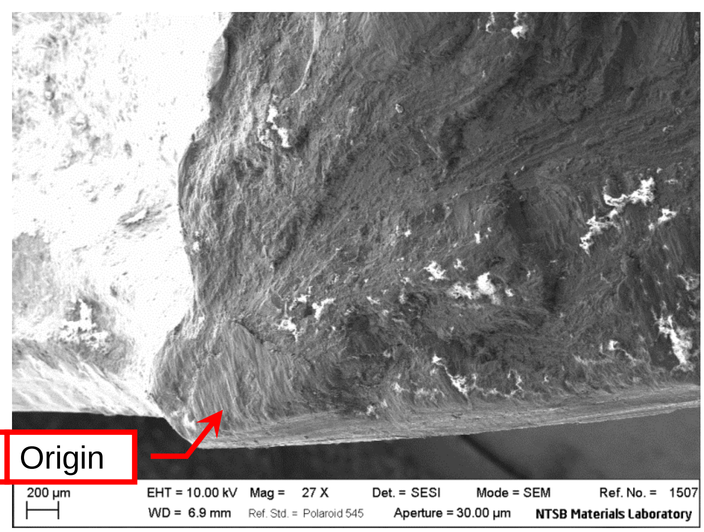
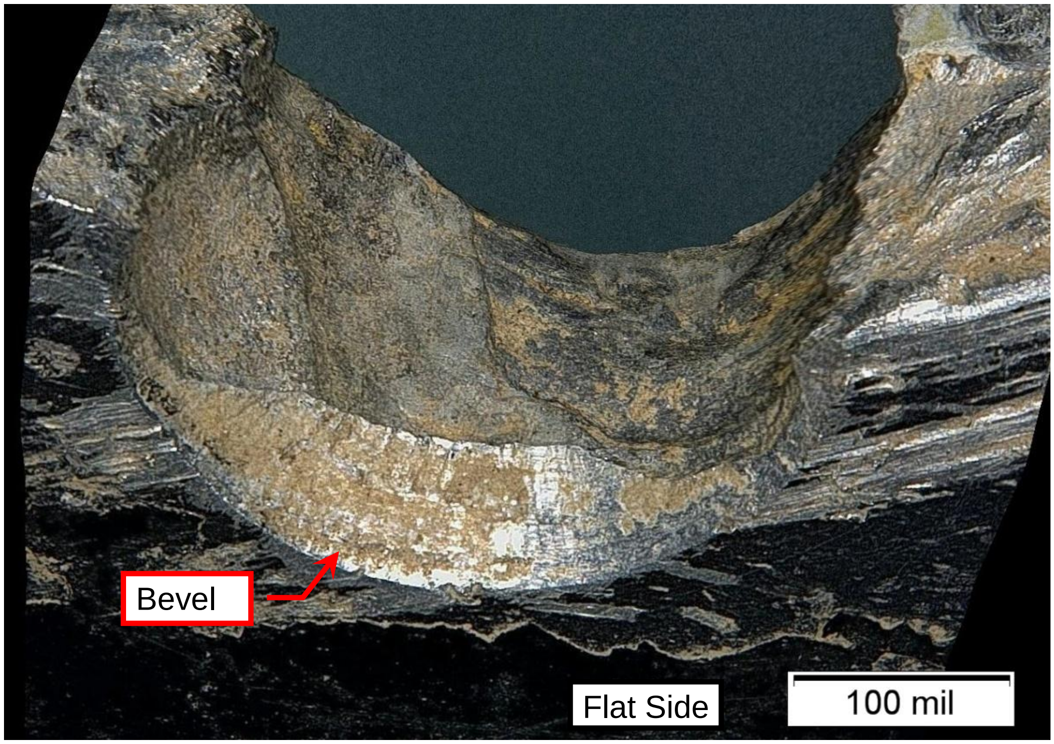


Figure 2. The entire blade fracture face at top with the approximate fatigue terminus at the dashed yellow line. Left view show a close-up of the hole with the approximate fatigue origin locations denoted. SEM views of the fatigue origins are shown below.







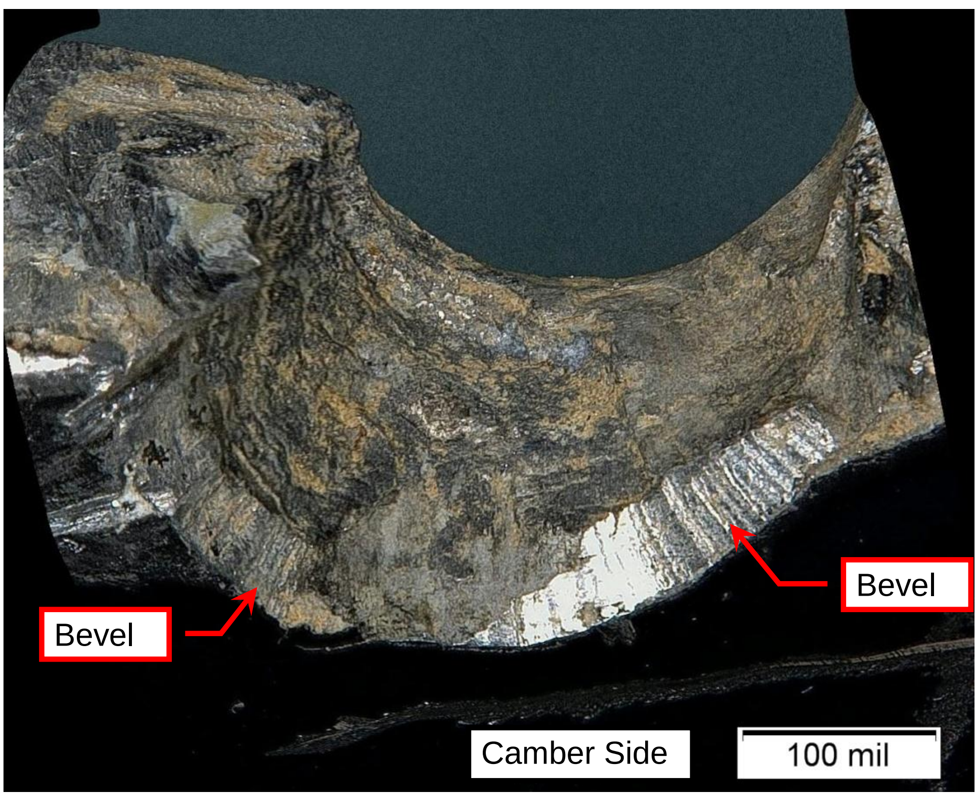


Figure 3. Optical 3-dimensional reconstructions of the hole and surroundings showing the surface features of the hole and the beveled edges on both the flat (top) and camber (bottom) sides.

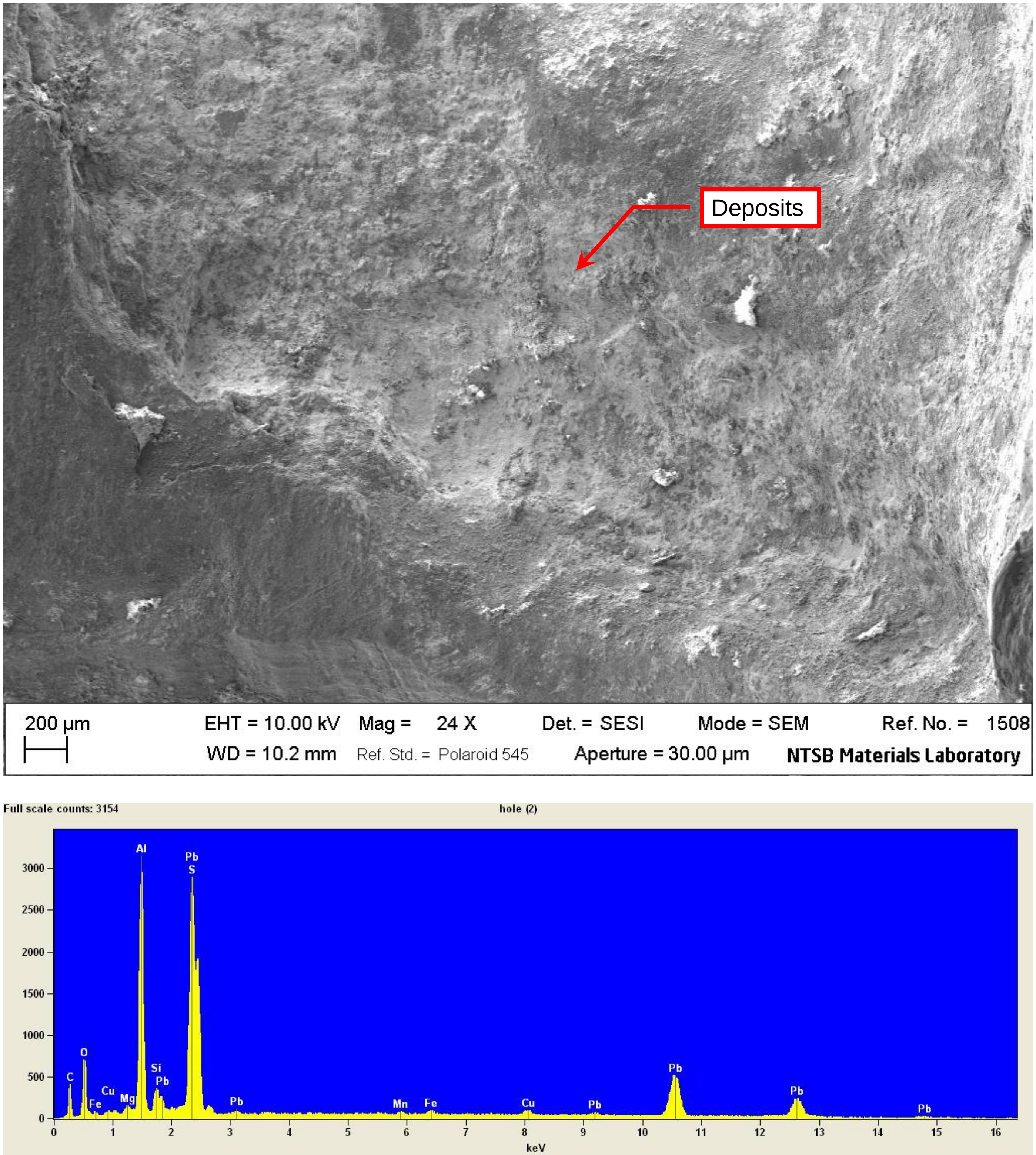


Figure 4. SEM (secondary electron) view at top of a portion of the hole surface showing lead (Pb) deposits as whitish areas. Below, an EDS spectrum of the deposits showing strong lead peaks.

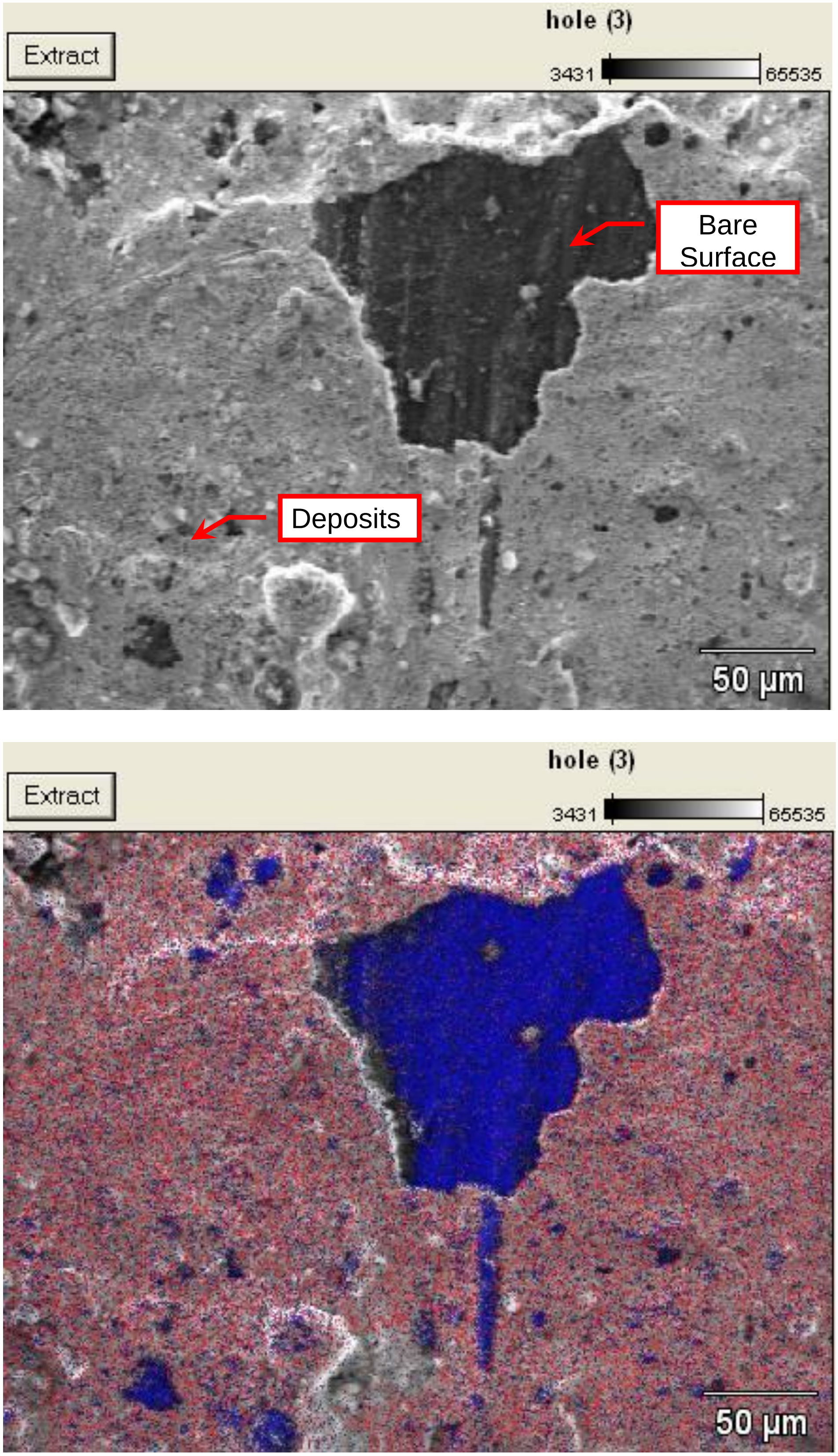


Figure 5. Closer SEM image of the deposits on the hole surface at left with a EDS map below showing the location of lead in the deposits (red dots) and the underlying aluminum Blue dots) of the blade.

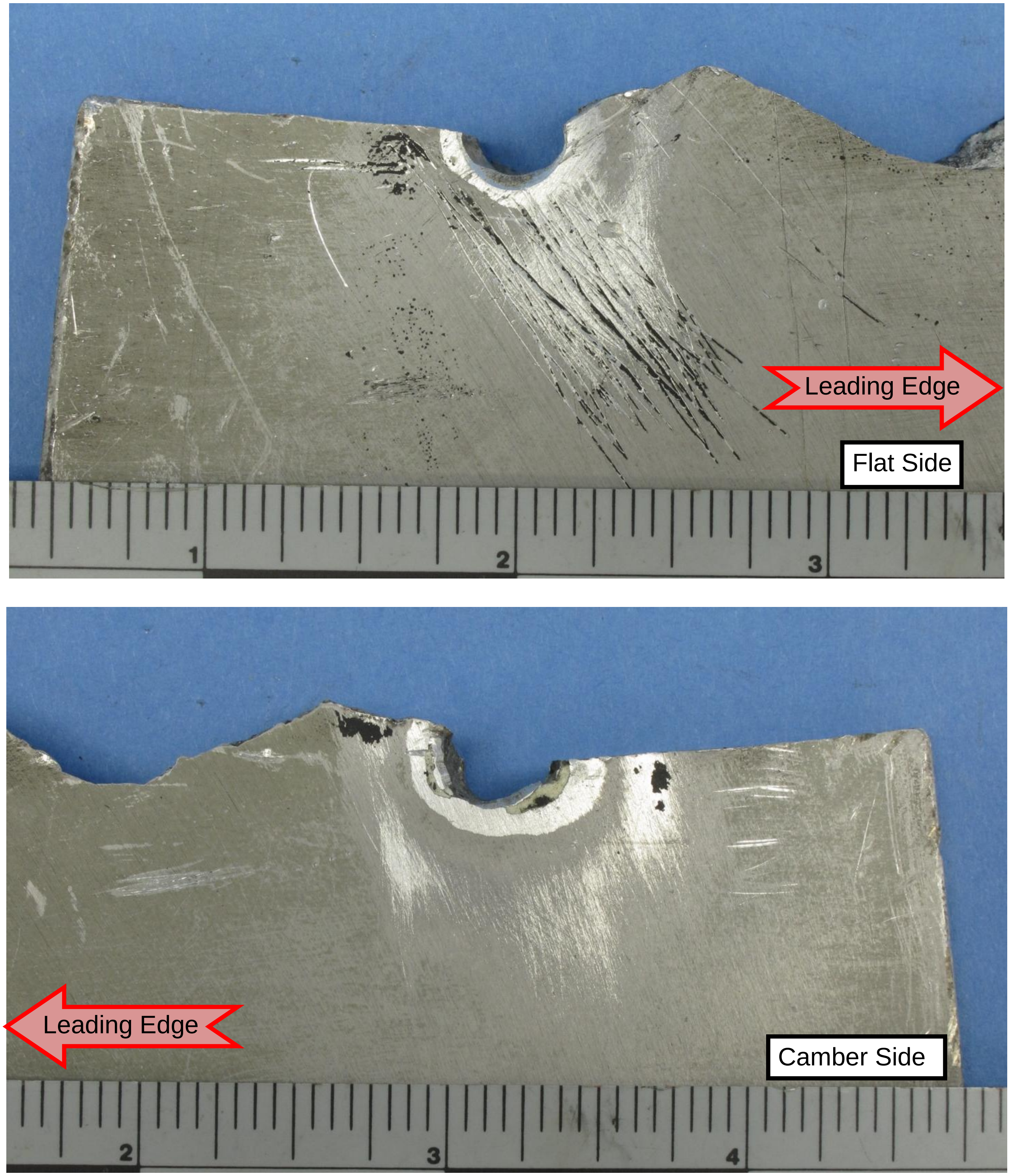


Figure 6. The flat and camber surfaces of the blade after the paint was removed. Reworked areas visible as shiny regions around the hole.

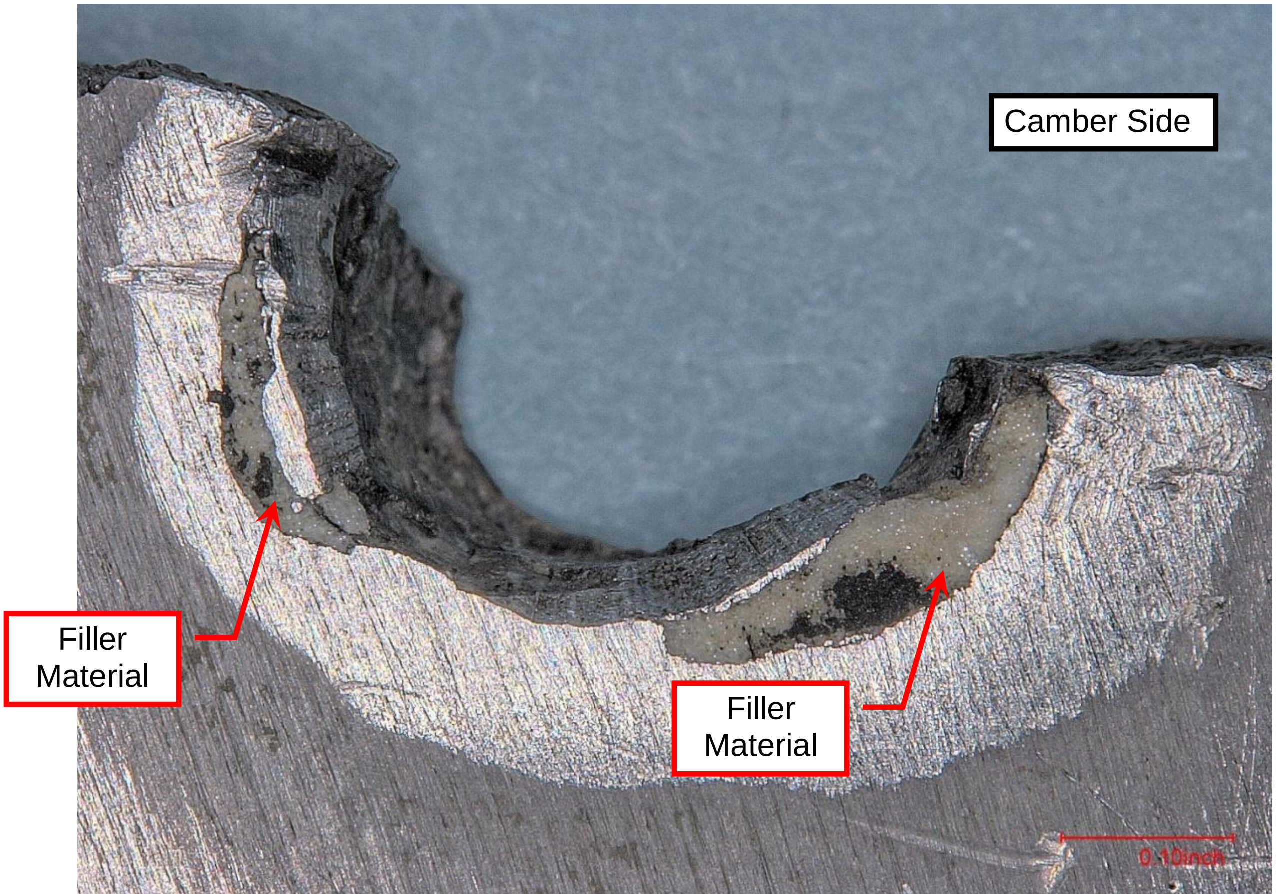
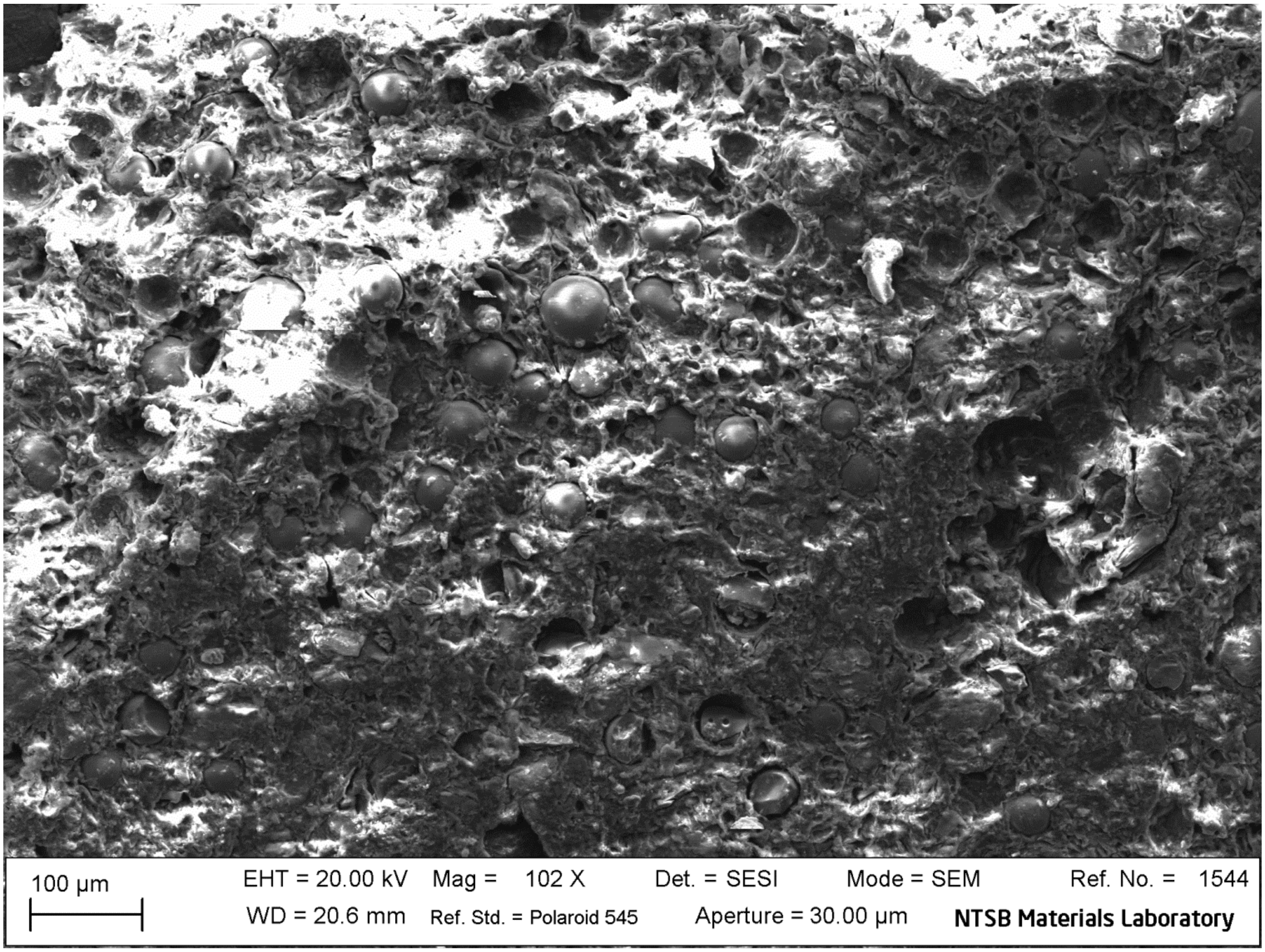


Figure 7. The camber side of the blade showing the two areas of filler around the hole at top. Closer view of the right hand area displayed at left.



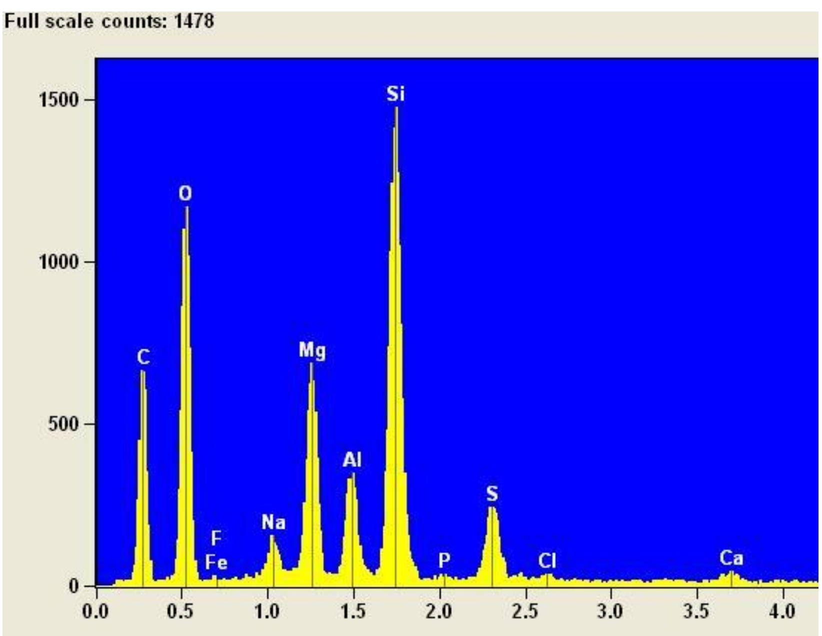


Figure 8. SEM view of the filler metal at top with glass beads visible. EDS spectrum of the bulk filler at left.