NATIONAL TRANSPORTATION SAFETY BOARD
Office of Research and Engineering
Materials Laboratory Division
Washington, D.C. 20594

April 11, 2018

MATERIALS LABORATORY FACTUAL REPORT Report No. 18-031

A. ACCIDENT INFORMATION

Place	:	Honolulu, HI
Date	:	February 13, 2018
Vehicle	:	Boeing 777 (United Airlines)
NTSB No.	:	DCA18IA092
Investigator	:	Jim Hookey (AS-40)

B. COMPONENTS EXAMINED

Fuselage skin pieces.

C. DETAILS OF THE EXAMINATION

A fan blade separation resulted in damage to the inlet, engine cowl, and surrounding aircraft structure. Several areas on the fuselage had impact marks from debris that had exited the engine during the event. Two pieces of fuselage were excised and sent to the Materials Laboratory for analysis. The pieces are shown in Figure 1 thru Figure 3. One piece consisted of only fuselage (Figure 1), while the other piece had fuselage skin still attached to a portion of stringer substructure (Figure 2 and Figure 3). The stringer had separated along the longitudinal rib, as indicated by the red arrows in Figure 2.

The fuselage piece in Figure 2 was sectioned from the stringer. Both fuselage pieces were then examined using a Zeiss Auriga 40 field emission (FE) scanning electron microscope (SEM), with Energy Dispersive X-Ray Spectroscopy (EDS).

Both pieces had multiple gouges and embedded particles in their surfaces. The embedded particles had a distinctly different appearance than the fuselage skin when viewed using backscattered electron (BSE) imaging. SEM images of exemplar embedded particles in the unattached fuselage piece and the fuselage piece attached to the stringer are shown in Figure 4 and Figure 6.

EDS elemental maps of the embedded particles showed they were rich in titanium and vanadium, and had less aluminum when compared to the surrounding fuselage skin. EDS spectra of the embedded particles were consistent with Ti-6-4 titanium alloy. The corresponding EDS elemental dot maps and EDS spectra of the exemplar embedded particles are shown in Figure 5 and Figure 7.

The separated fan blade was made from Ti-6-4 titanium alloy, while the fuselage skin was made from an aluminum alloy.

Adrienne V. Lamm
Materials Engineer

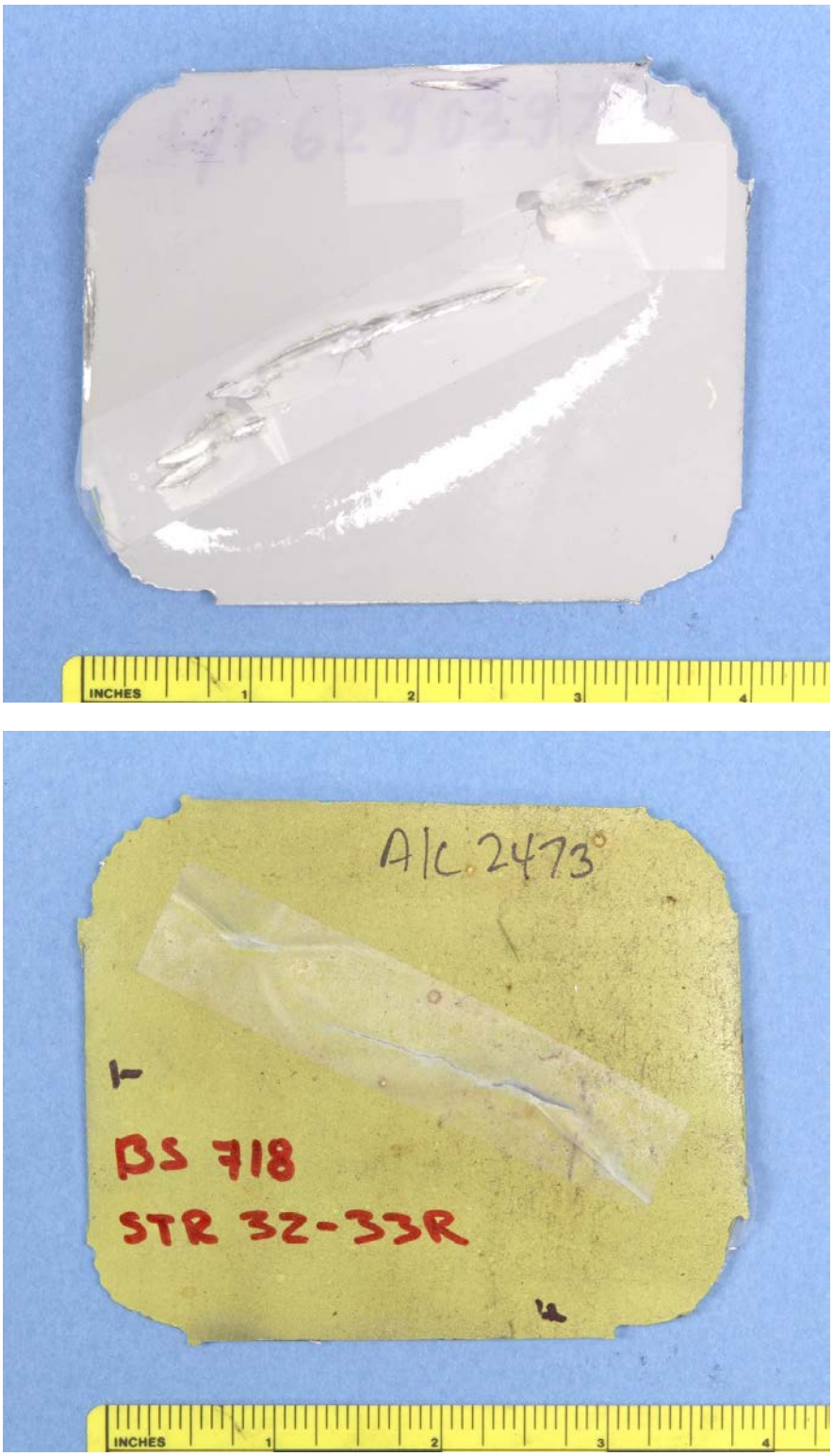

Figure 1: Overall photos of the unattached piece of fuselage. The top photo shows impact marks on the painted external surface of the piece.

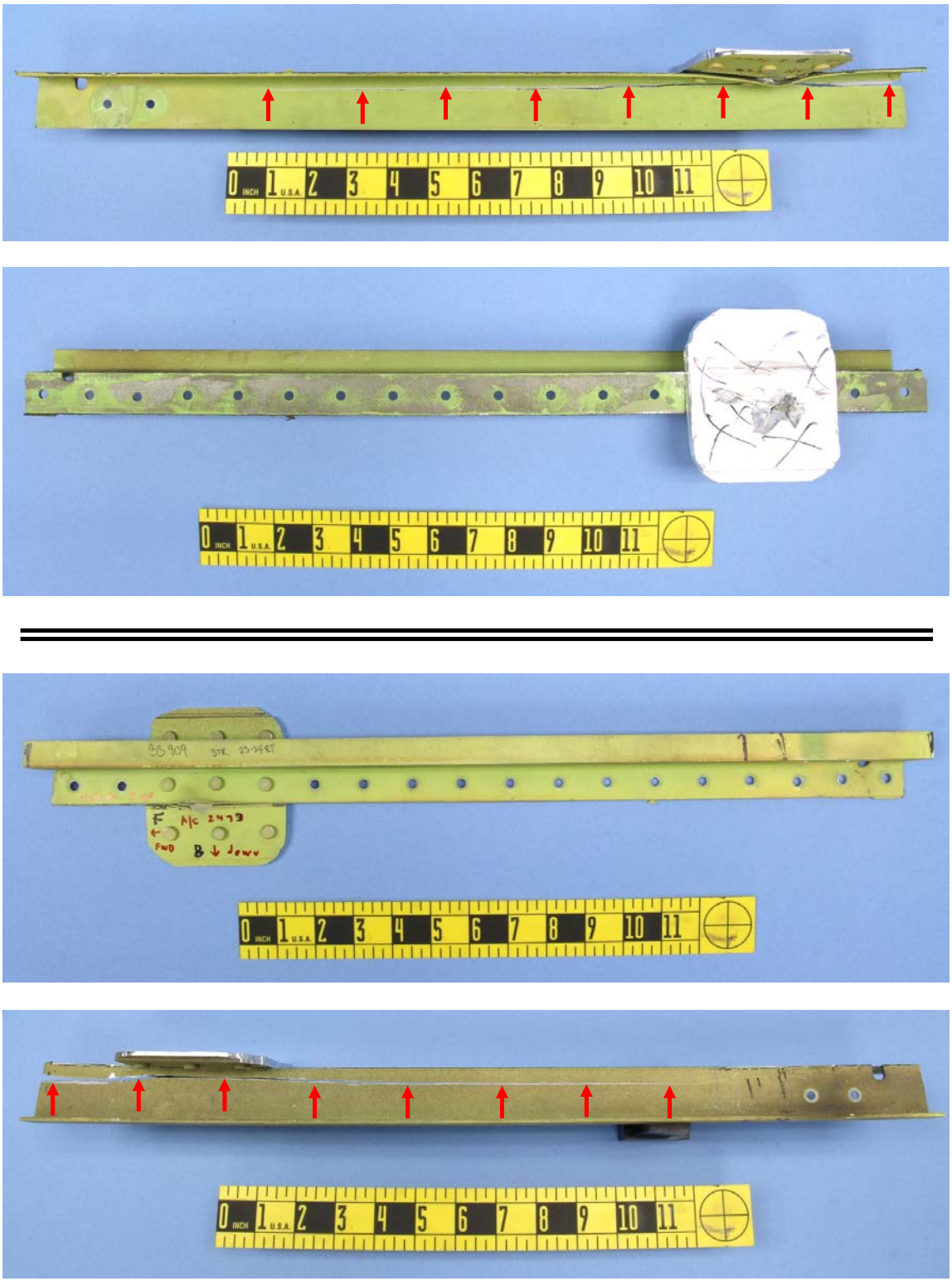

Figure 2: Overall photos of the piece of fuselage still attached to the stringer. The red arrows point to a separation in the rib of the stringer.

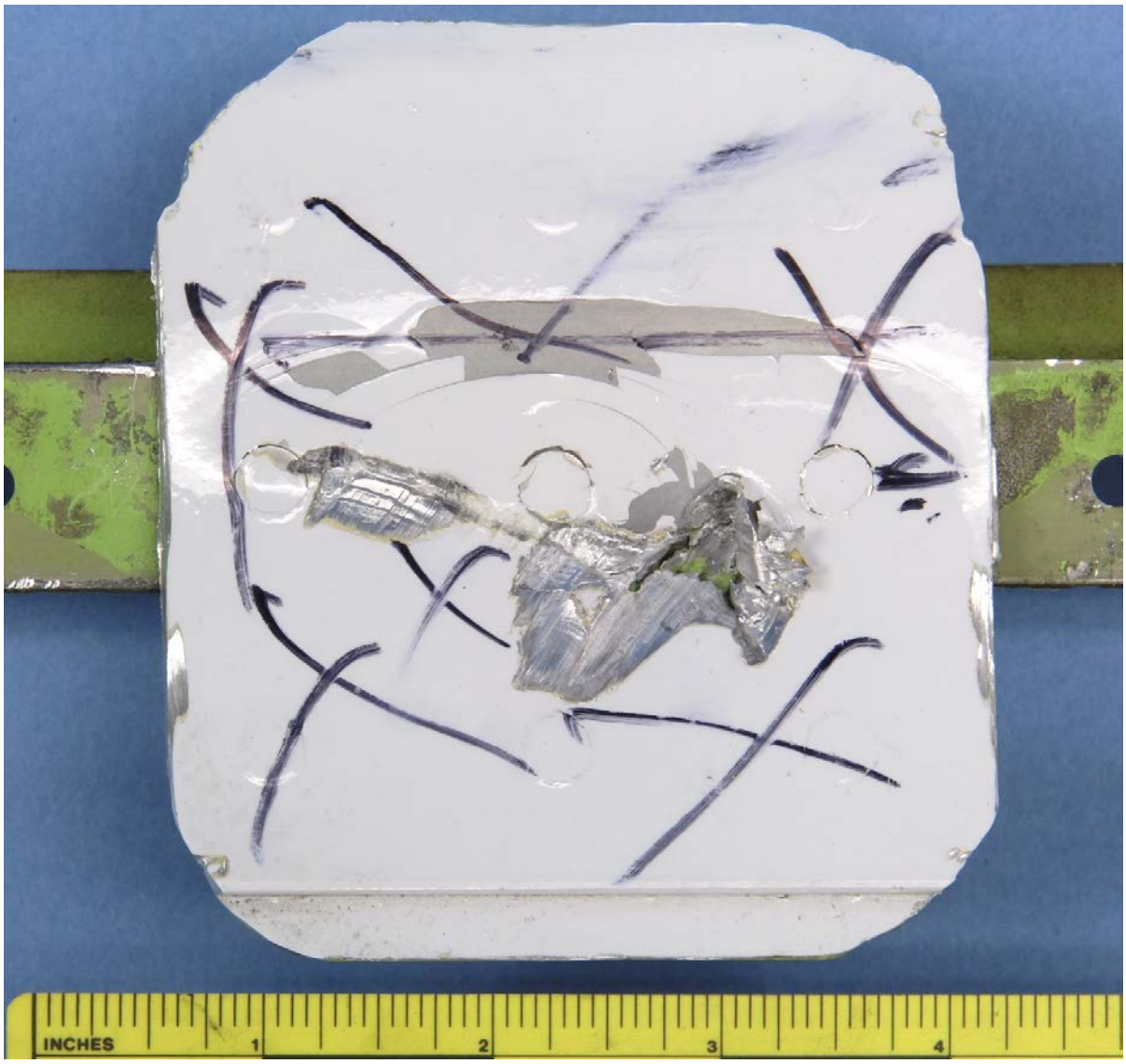

Figure 3: Close-up photo of the piece of fuselage still attached to the stringer. Impact marks were visible on the painted external surface of the piece.

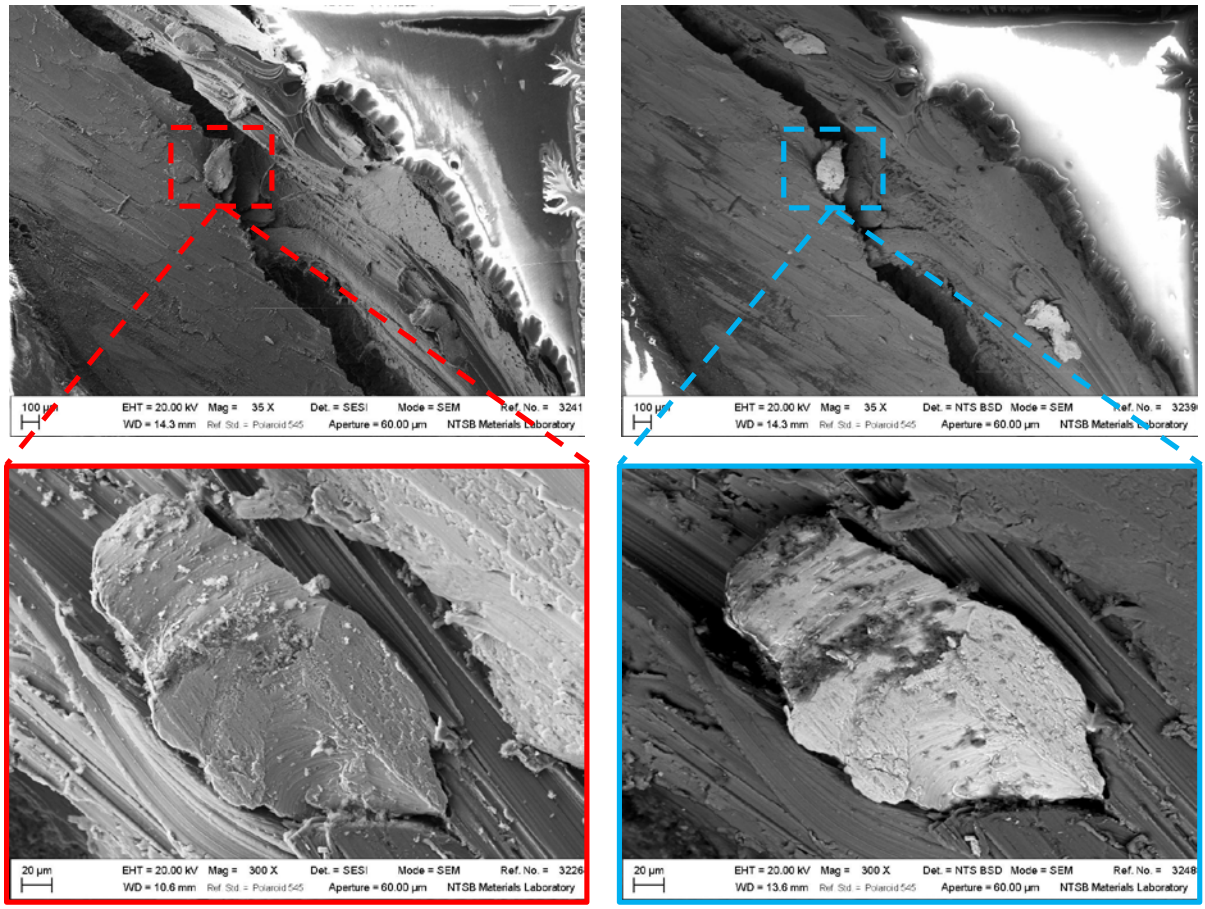

Figure 4: Secondary electron (left) and BSE (right) SEM images of an exemplar embedded particle in the surface of the unattached piece of fuselage.

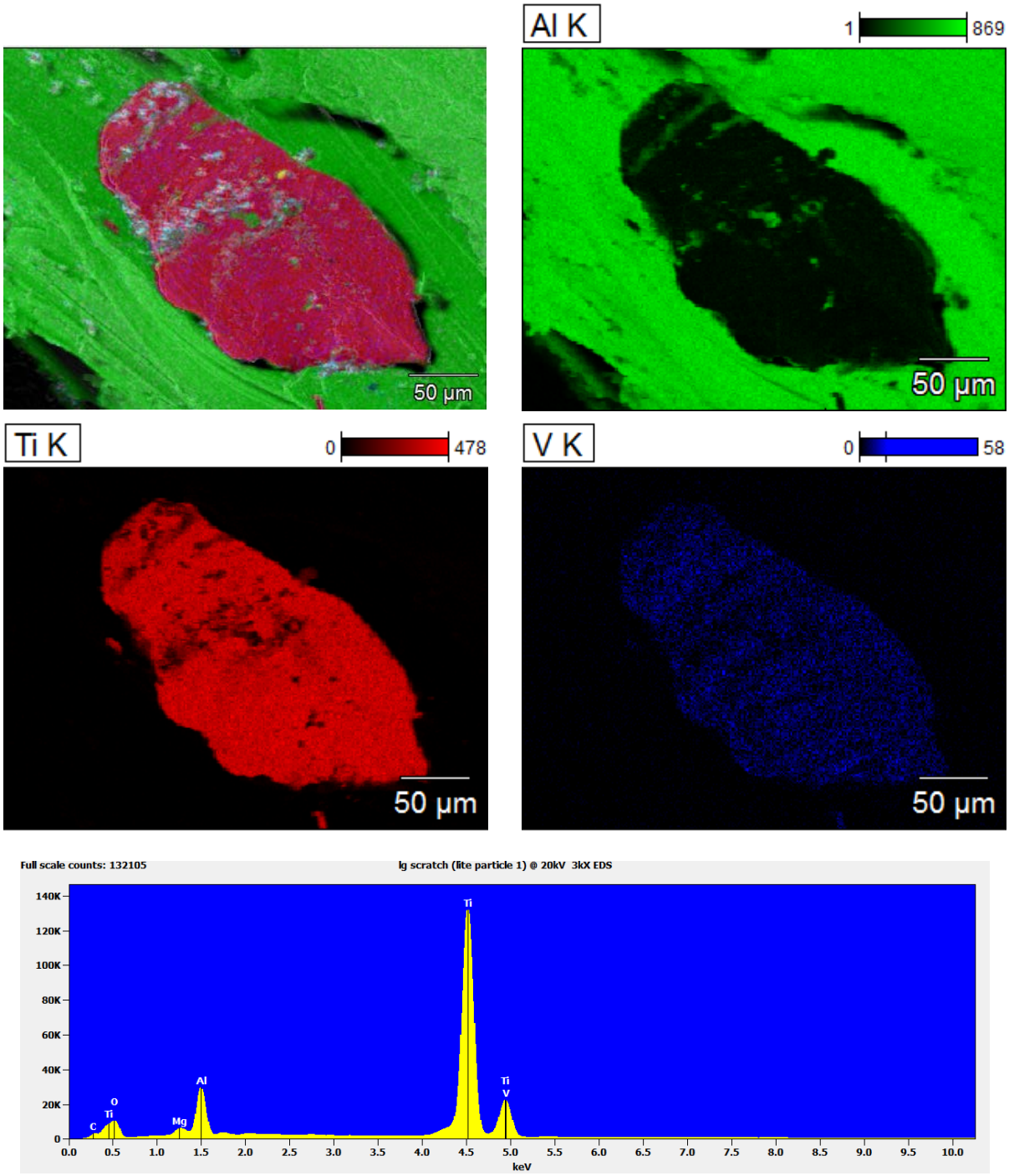

Figure 5: EDS elemental dots maps of the exemplar embedded particle in the surface of the unattached piece of fuselage from Figure 4 are shown in the top 4 images. Clockwise from the top right the images show the presence of aluminum, vanadium, and titanium, and the top left image is a composite of the 3 elements. The bottom image shows the EDS spectrum of the embedded particle, which was consistent with Ti-6-4 titanium alloy.

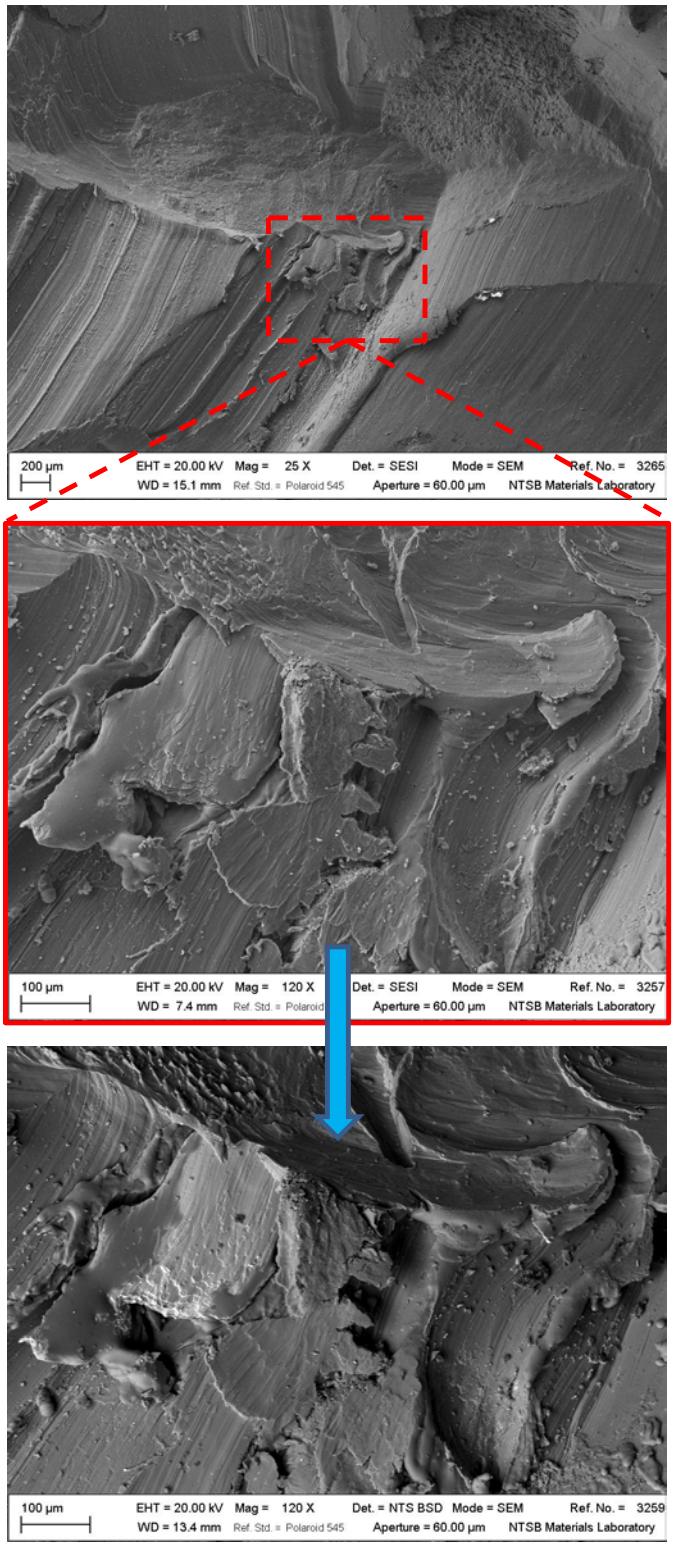

Figure 6: Secondary electron (top and middle) and BSE (bottom) SEM images of an exemplar embedded particle in the surface of the piece of fuselage still attached to the stringer.

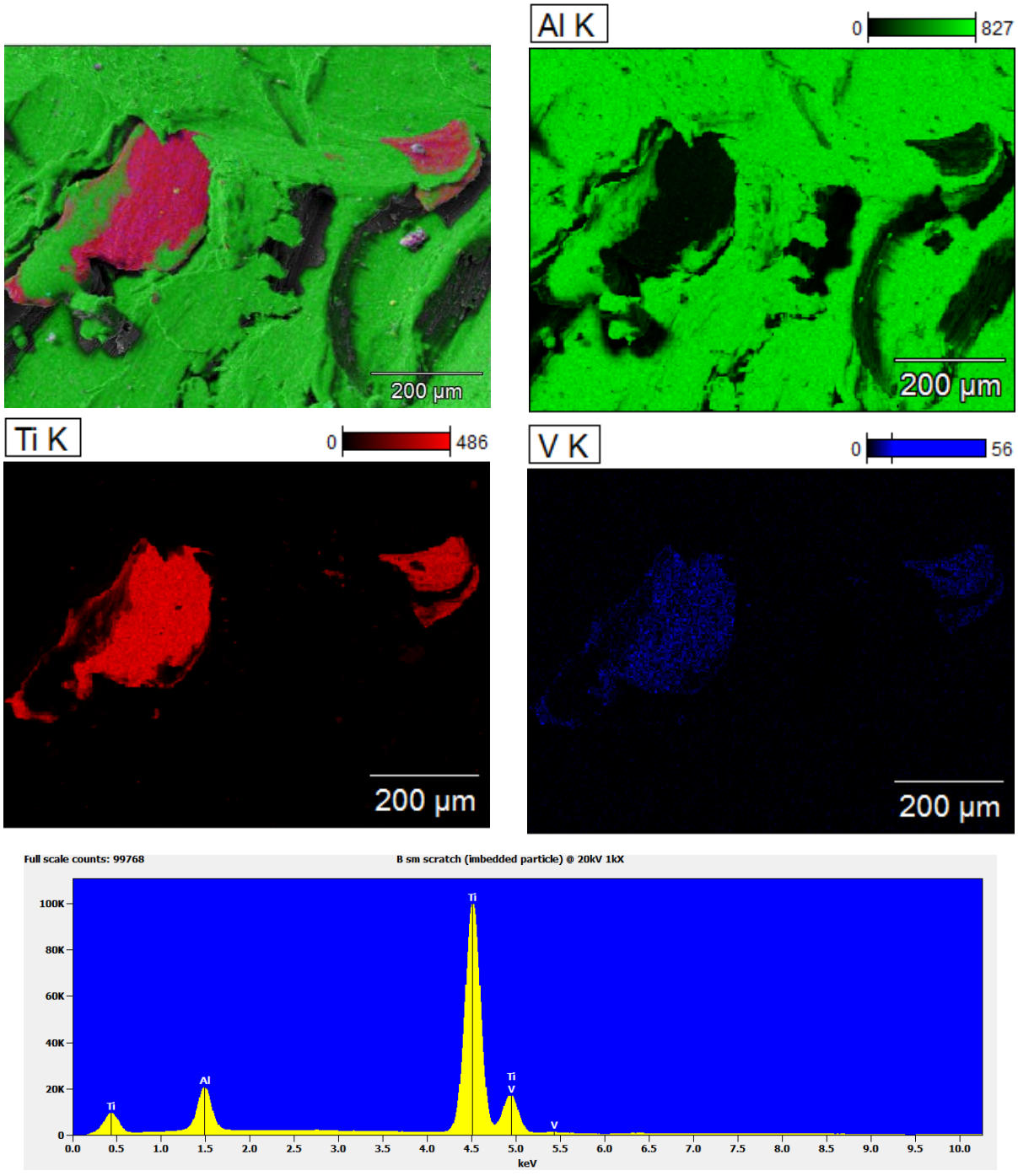

Figure 7: EDS elemental dots maps of the exemplar embedded particle in the surface of the piece of fuselage still attached to the stringer from Figure 6 are shown in the top 4 images. Clockwise from the top right the images show the presence of aluminum, vanadium, and titanium, and the top left image is a composite of the 3 elements. The bottom image shows the EDS spectrum of the embedded particle, which was consistent with Ti-6-4 titanium alloy.