

NATIONAL TRANSPORTATION SAFETY BOARD

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



April 8, 2022

MATERIALS LABORATORY FACTUAL REPORT

Report No. 22-012

A. ACCIDENT INFORMATION

Place : McDermott, Ohio
Date : May 28, 2021
Vehicle : Lancair Evolution, N515DL
NTSB No. : CEN21FA238
Investigator : Mike Folkerts, AS-CEN

B. COMPONENTS EXAMINED

Windshield pieces.

C. DETAILS OF THE EXAMINATION

Pieces of the windshield from the accident airplane as recovered from the impact location were received as shown in figure 1. Although no evidence of a pre-impact failure was noted in the preliminary findings, the pieces were submitted for examination at the request of the NTSB laboratory.

As installed in the airplane, the interior and exterior surfaces around the perimeter of the windshield are roughened and bonded to the composite fuselage. Most of the pieces shown in figure 1 were middle pieces that did not intersect the bond area at the windshield perimeter. Among the submitted pieces, the piece shown in figure 2 was selected as a representative sample of the windshield bond area and edge profile that was chosen for further examination.

The selected windshield piece was cleaned using a solution of Alconox and water, and surface debris was removed by gentle brushing with a soft-bristle brush. The finished outer edge of the selected piece had a rounded profile as shown in figure 3, a feature consistent with the profile shown in build instructions for the window installation.

The bond areas had a frosted appearance as shown in figure 2. Upon closer examination, a scratch pattern of overlapping elliptical scratches was observed as shown in figure 4. According to build instructions, the bond area of the windshield is sanded with a dual action (DA) sander with 40-grit paper to produce a frosted appearance before the windshield is bonded to the frame.

A 3D representation of typical sanding marks on the bond area was obtained with a Keyence VHX-7000 microscope set at 80x magnification. A tilt correction was applied

to the entire field of view, and a color-coded depth profile was obtained. Next a depth profile chart was obtained for a linear trace across the surface. The resulting image and profile measurements for the typical area of scratches is shown in figure 5. The deepest scratch in the field of view had measured peak-to-valley height difference of 0.00067 inch to 0.00075 inch (17 micrometers to 19 micrometers).

Next, the windshield piece shown in figure 2 was examined using a scanning electron microscope (SEM). The bond surface scratches were examined at varying magnifications, and the typical appearance of scratches on the bond surface are shown in figure 6.

The thickness of the windshield was measured on the clear portion of the piece shown in figure 2. The thickness measured 0.3733 inch

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Senior Materials Engineer



Figure 1. Overall view of the box of submitted windshield pieces.



Figure 2. View of a piece from the windshield perimeter after cleaning with a solution of Alconox and water and light brushing.

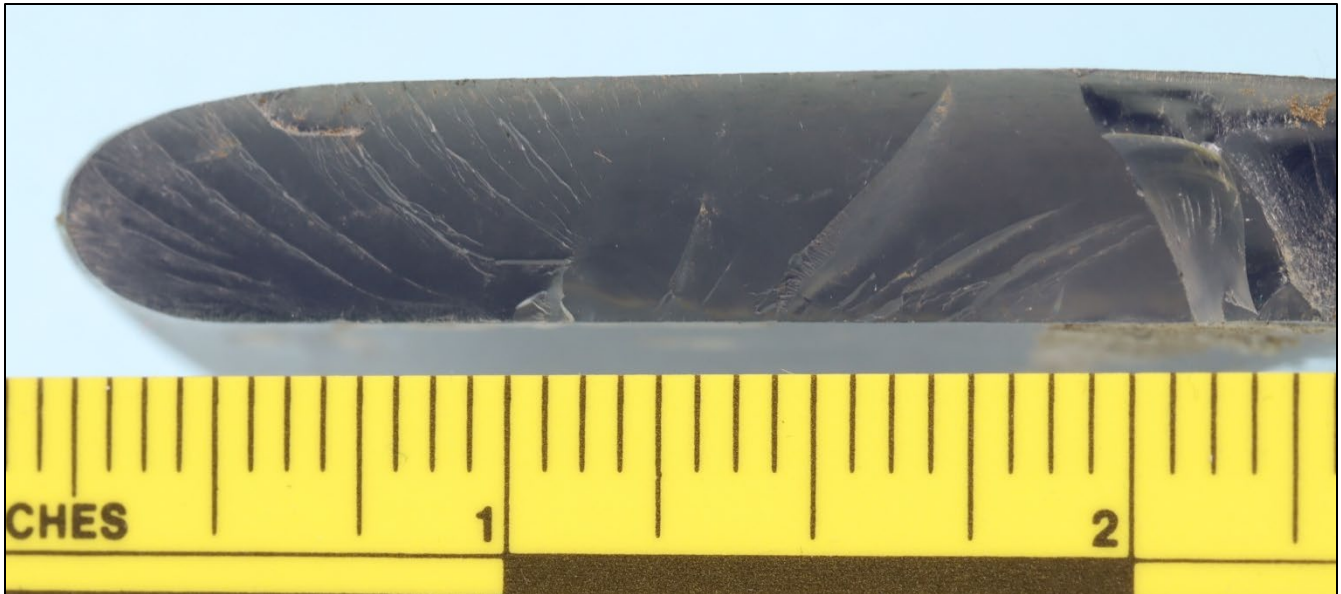


Figure 3. Fracture surface on the piece from figure 2 showing the rounded profile at the outer edge.



Figure 4. Typical scratch pattern on the bond surface on the exterior of the piece shown in figure 2.

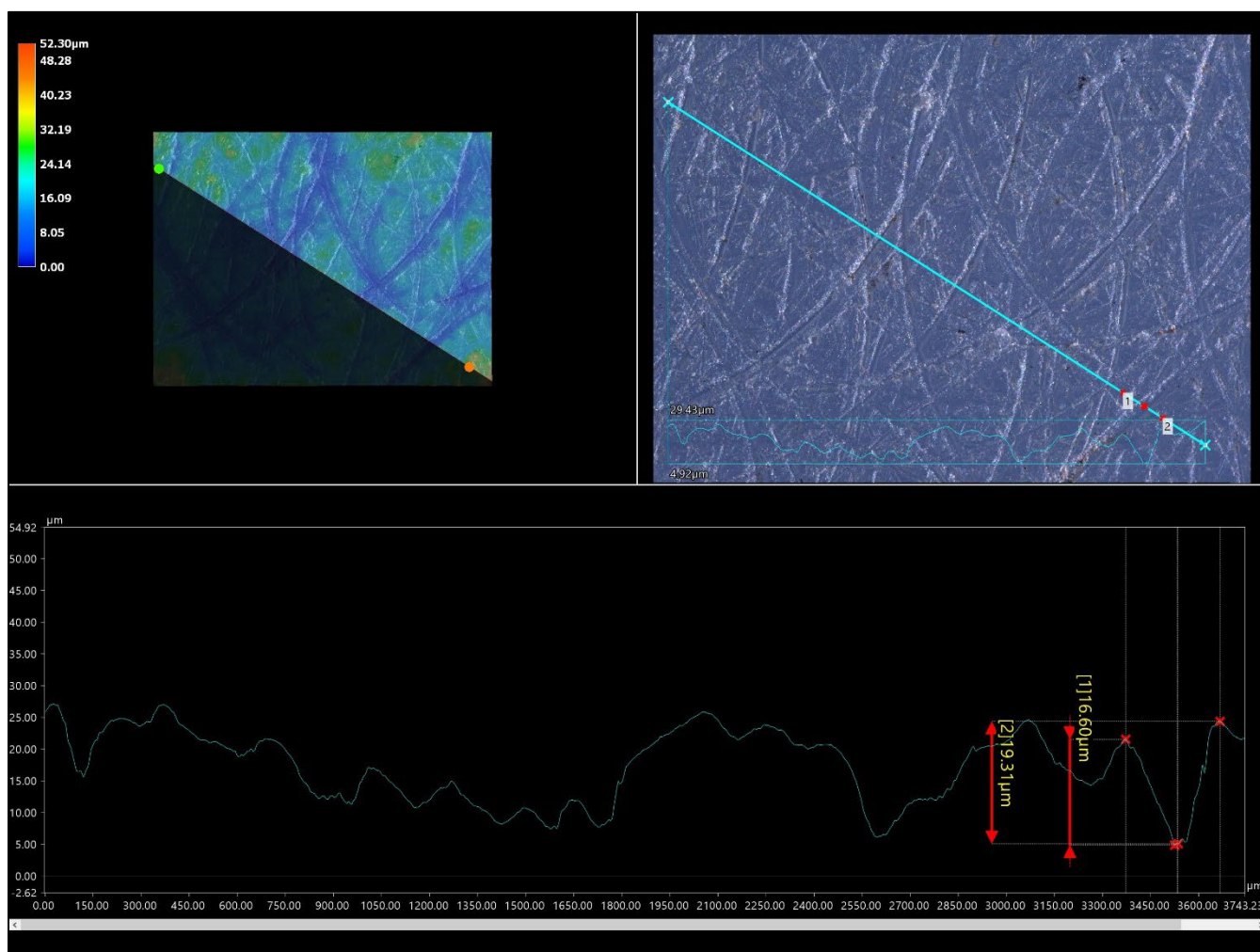


Figure 5. Color-coded 3D height map (upper left) of the bond surface area (upper right image) with relatively deep elliptical scratches near the origin and a chart showing relative height differences along the trace shown by the blue line in the upper right image.

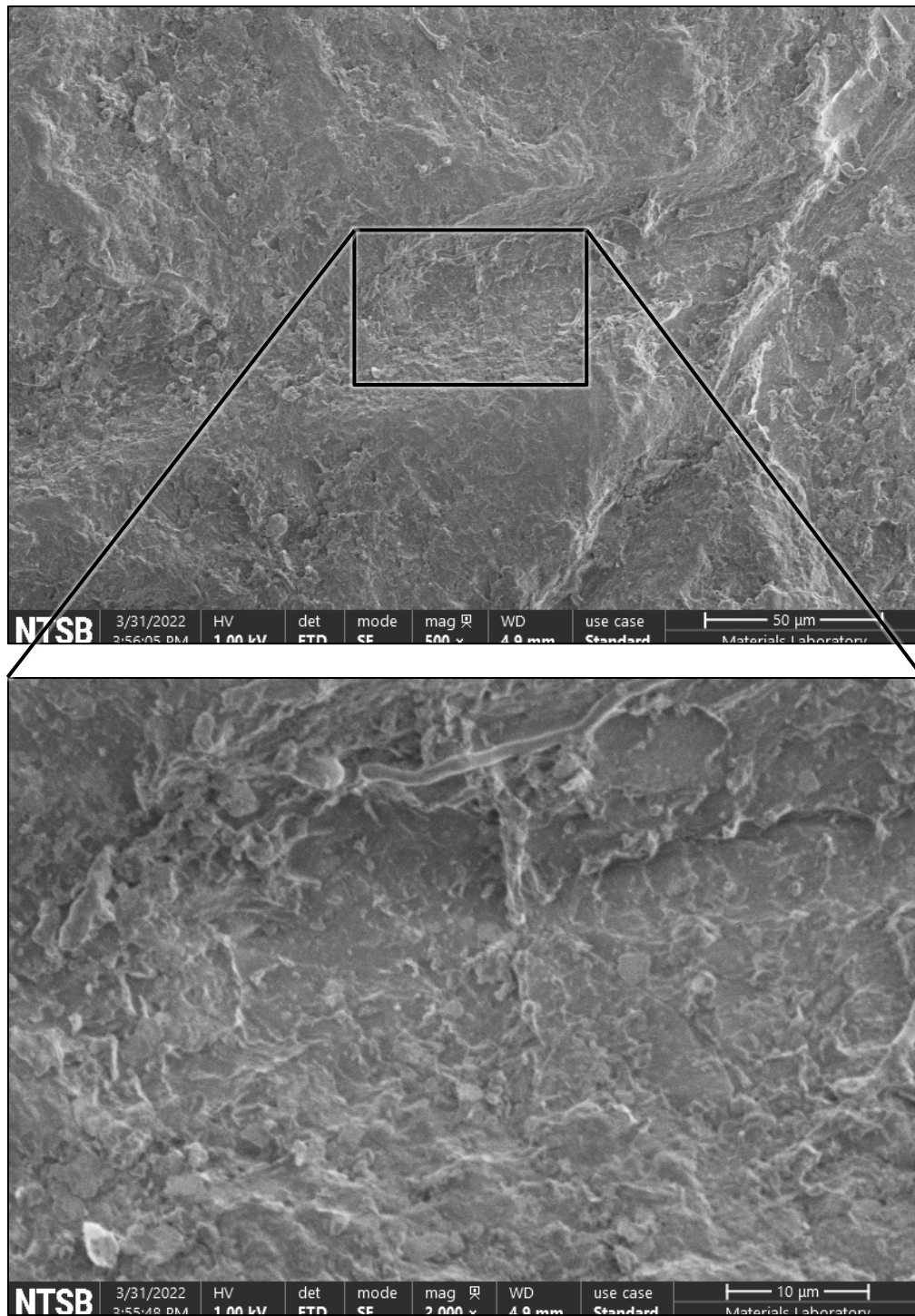


Figure 6. SEM images of the bond surface.