

NATIONAL TRANSPORTATION SAFETY BOARD

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



September 30, 2015

MATERIALS LABORATORY FACTUAL REPORT

Report No. 15-080

A. ACCIDENT INFORMATION

Place : Miami, Florida
Date : February 11, 2015
Vehicle : Beech 1900C
NTSB No. : ERA15FA129
Investigator : Robert Gretz, AS-ERA

B. COMPONENTS EXAMINED

Pieces of reversing lever, guide pin and bracket assembly

C. DOCUMENTS REVIEWED

1. Pratt & Whitney Canada, Materials Investigation Laboratory Report ME16364FS.
2. Pratt & Whitney Canada Engineering Drawing—Lever, Propeller Reversing 3044659.
3. Pratt & Whitney Canada Engineering Drawing—Bracket-Guide Pin, Reversing Lever, Assy of 3104350.
4. Pratt & Whitney Canada, Accessories Accident Investigation Report, RFA No.: 15ECN00136.

D. DETAILS OF THE EXAMINATION

After examination at the Pratt & Whitney Canada, Materials Investigation Laboratory, pieces of the reversing lever assembly and the guide pin and bracket assembly were sent to the NTSB Materials Laboratory for evaluation. The purpose of the evaluation is to document markings on the reversing lever and guide pin to determine if the reversing lever had been installed per specification relative to the guide pin.

An accident-scene view of the reversing lever and guide pin installation on the aircraft engine is shown in Figures 1, 2, and 3. Closer views of the position of the reversing lever tip and the guide pin are shown in Figure 2, and 3. In Figure 3a, an isometric engineering drawing shows the as-designed position of the reversing lever tip relative to the guide pin. Figure 3b, shows the position of the reversing lever tip relative to the guide pin after the accident.

Images of the reversing lever are showing in Figure 4. The tip of the reversing lever had been previously cut during an exam at Pratt & Whitney Canada. The flat sides of the lever arm are arbitrarily labeled A and B as shown in the figure. Closer views of the tip of the lever arm are shown in Figure 5. As indicated in the figure, a wear scar was observed on side A of the tip which is consistent with as-designed contact with the guide pin. The guide pin exhibits a complimentary wear scar where it contacts the reversing lever tip as shown in Figure 6a. No wear scars or contact marks were present on side B of the reversing lever tip as indicated in the figure.

Views of the guide pin and bracket assembly are shown in Figure 6. The bracket exhibited in-plane bending deformation such that as-installed it is no longer perpendicular to the axis of the propeller (see Figure 6b). The guide pin surface exhibited a wear scar consistent with contact with reversing lever as shown in Figure 6a. Extending from the reversing-lever contact-wear scar is an axially-oriented scoring wear scar that also exhibits galling wear features as identified in Figures 6a and 6c. The scoring and galling wear scar transitions to a radial path as it approaches the tip of the guide pin (see Figure 6c). For reference, the complimentary guide-pin contact-wear scar on the reversing lever tip is shown in Figure 6d.

A closer view of the guide pin wear scars is shown in Figure 7a. As indicated, a scoring and galling wear scar extends from the lever arm contact wear scar to the tip of the guide pin. There is deformed and smeared material along edge of reversing lever tip as identified in Figure 7b—consistent with contact with the guide pin.

In Figure 8a, the scoring and galling wear scar is consistent with guide pin contact with the corner of the reversing lever tip. The tip of the reversing lever is placed near the wear track for exemplar purposes. Other exemplar views of the sliding of the reversing lever tip corner along the length of the guide pin are shown in Figures 8b and 8c. As indicated in Figures 8d, 7a, 6d, and 5a, the corner of the reversing lever tip exhibited galling wear signatures and was examined by scanning electron microscopy (SEM) and chemically surveyed by energy dispersive spectroscopy (EDS) for material transfer.

A scanning electron micrograph of the reversing lever tip corner is shown in Figure 9. The white rectangular boxes indicate regions of EDS composition analysis. EDS spectra for the boxes labeled 1 through 4 are shown in Figures 10 and 11. An EDS spectra for the lever arm base material (taken on the cut surface of the tip) is shown in Figure 12. The guide pin is fabricated from type 304 stainless steel (as confirmed by EDS). The reversing lever is fabricated from cadmium-electroplated type 410 stainless steel. The EDS spectra for areas 1 and 2, reveal elevated nickel peaks which are consistent with tribo-transfer of type 304 stainless steel to the surface of the reversing lever tip corner. In the region near areas A and B in Figure 9, material excrescences are present at the tip corner consistent with galling wear.

Michael Budinski
Chief, Materials Laboratory



Figure 1 Image of side A (see Figure 3) of the reversing lever and guide pin and bracket assembly as-installed on the engine after the accident.

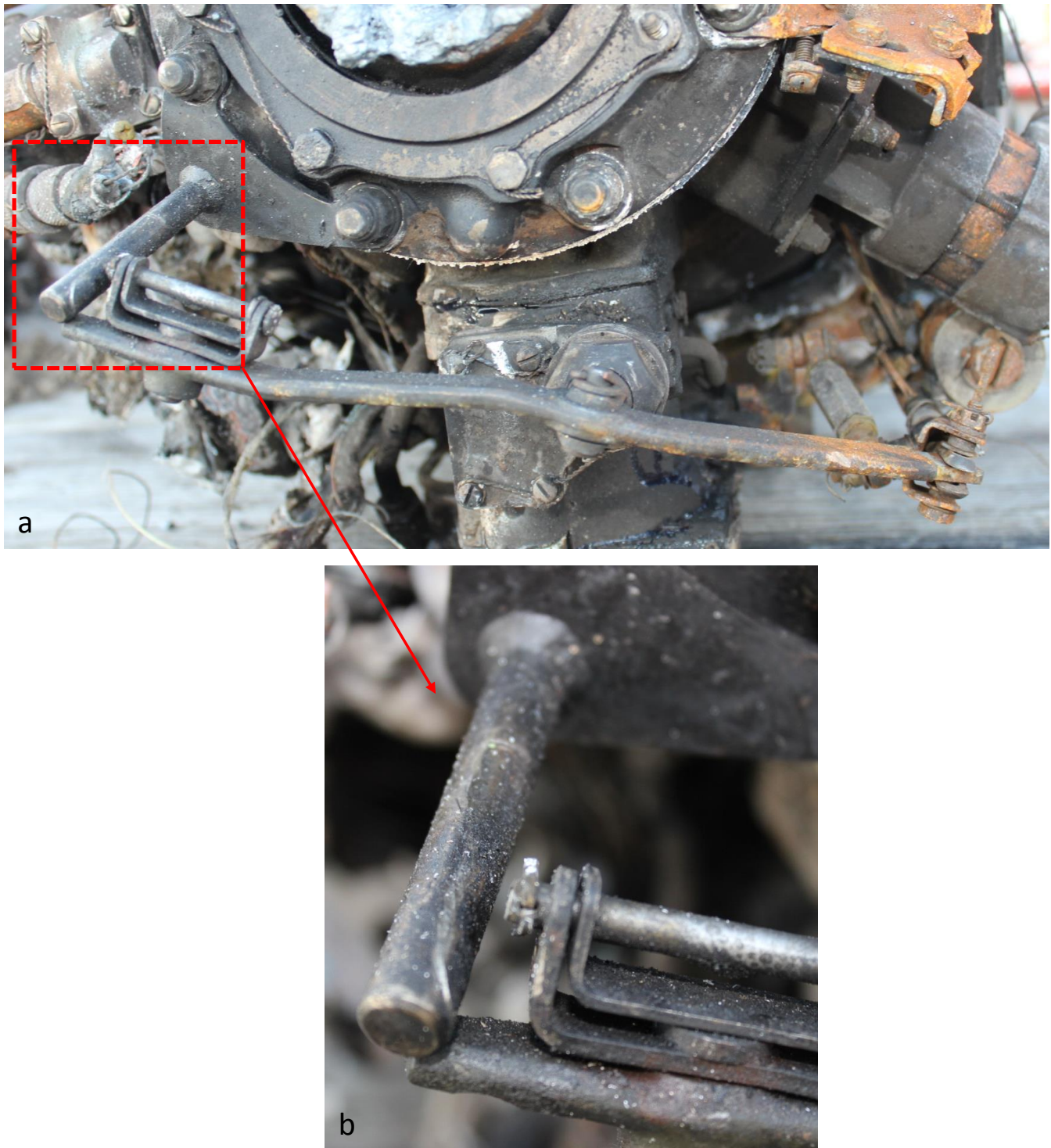


Figure 2 Images of side B (see figure 3) of the reversing lever and guide pin and bracket assembly as-installed on the engine after the accident. View b is a closer view of the mechanical interface between the tip of the reversing lever and the guide pin.

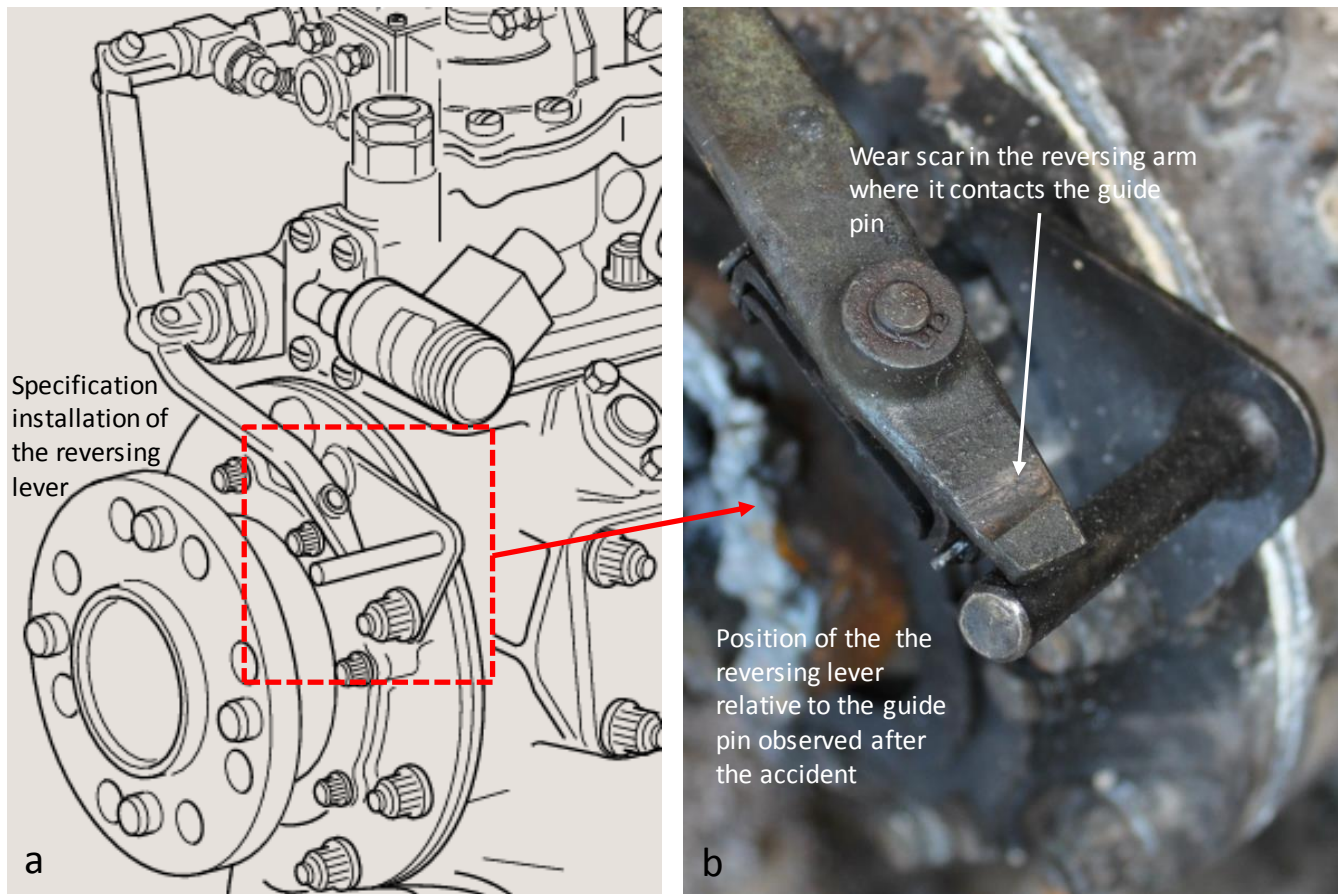


Figure 3 View a is an isometric engineering image of the reversing lever and guide pin mechanical interface. View b is a similar image of the reversing lever and guide pin mechanical interface after the accident. As indicated in view b, the tip of the reversing lever has been displaced from the specification position shown in view a. View b also shows a wear scar across the width of the reversing lever tip where normally contact with guide pin.

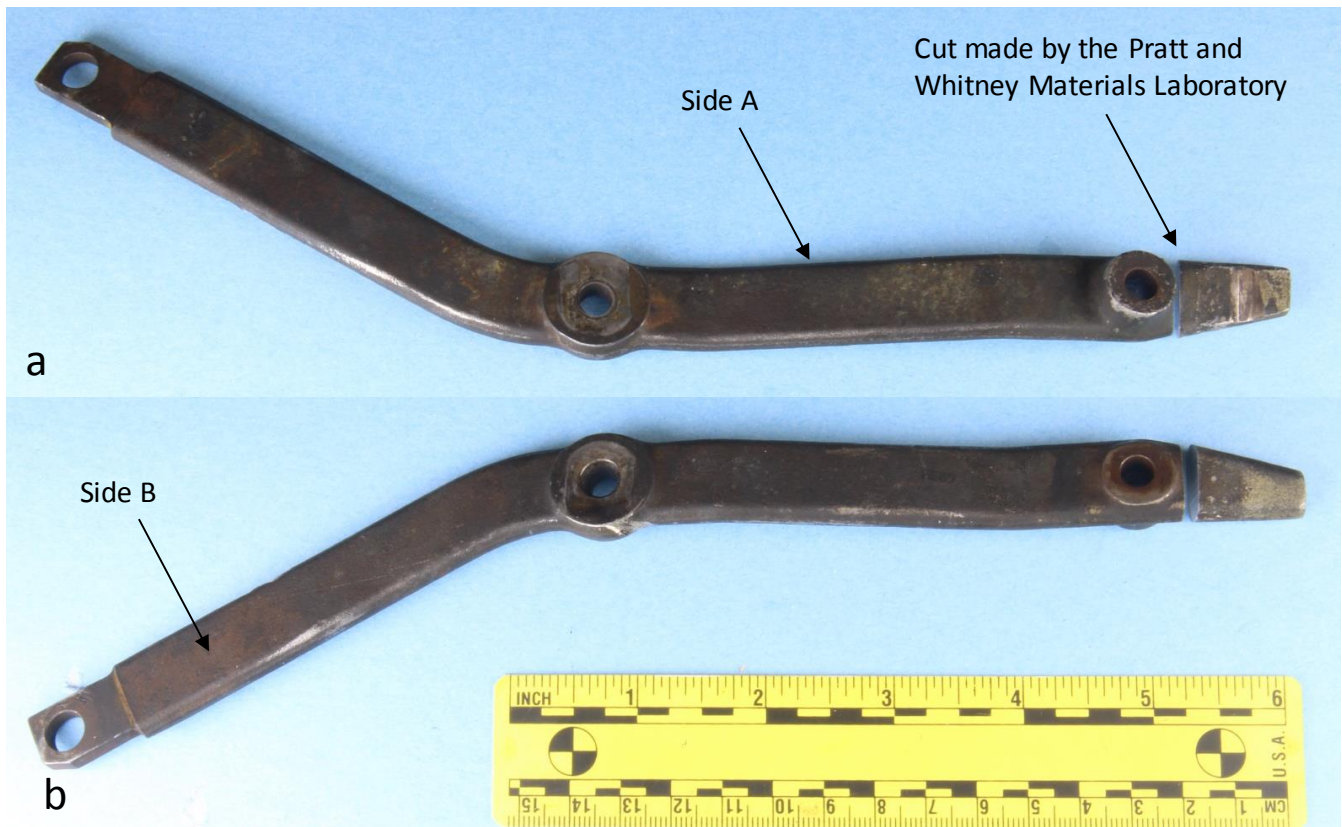


Figure 4 Images of the reversing lever after removal from the engine. The tip has been sectioned during previous work conducted by the Pratt and Whitney Materials Laboratory. In these images, the tip has been placed close to its pre-sectioning position.

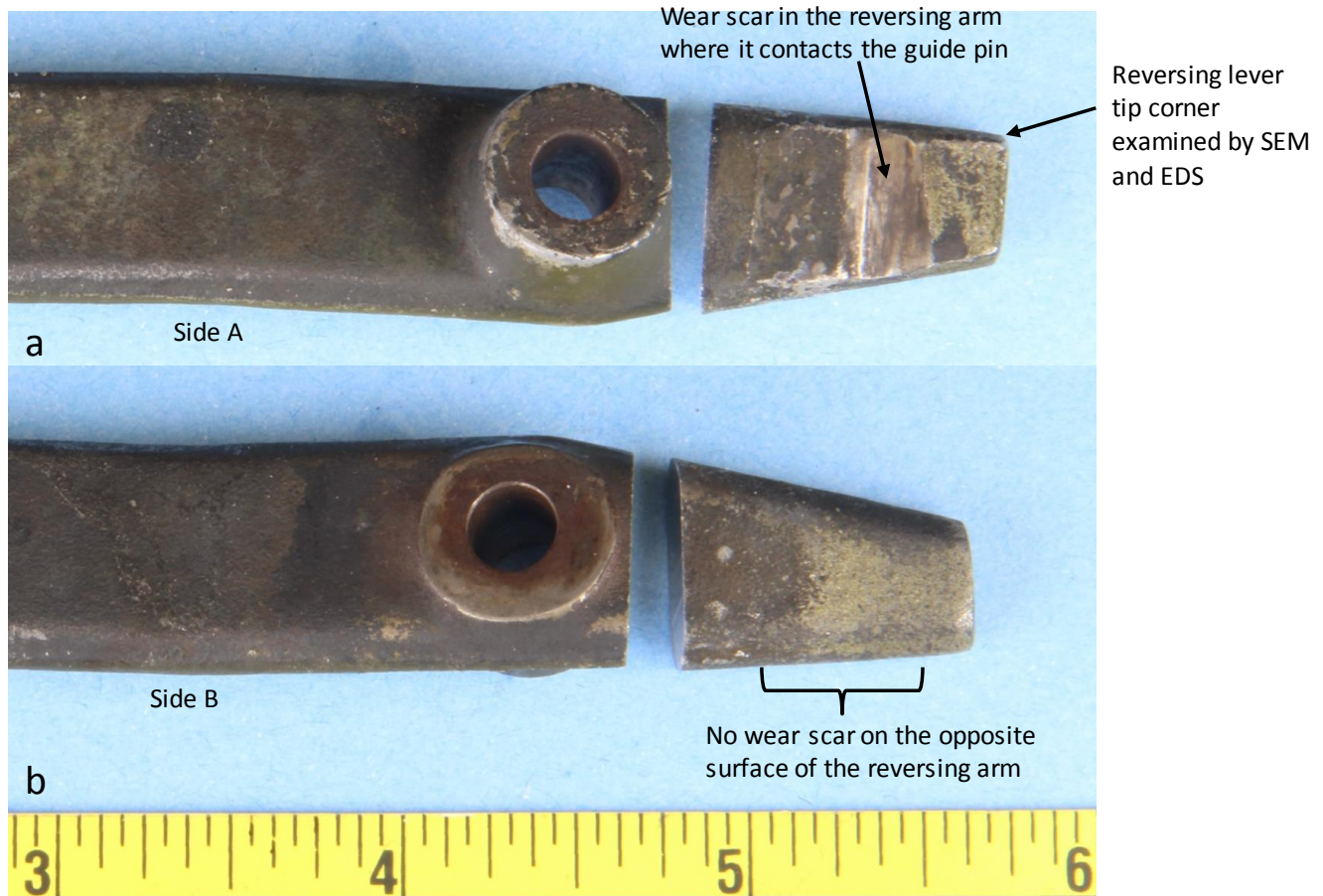


Figure 5 Closer images of the reversing lever tip after removal from the engine. The tip has been sectioned during previous work conducted by the Pratt and Whitney Materials Laboratory. In these images, the tip has been placed close to its pre-sectioning position. Wear scars are indicated in view a. In view b, side b of the tip was examined for wear scars in the region identified, but no scars were identified.

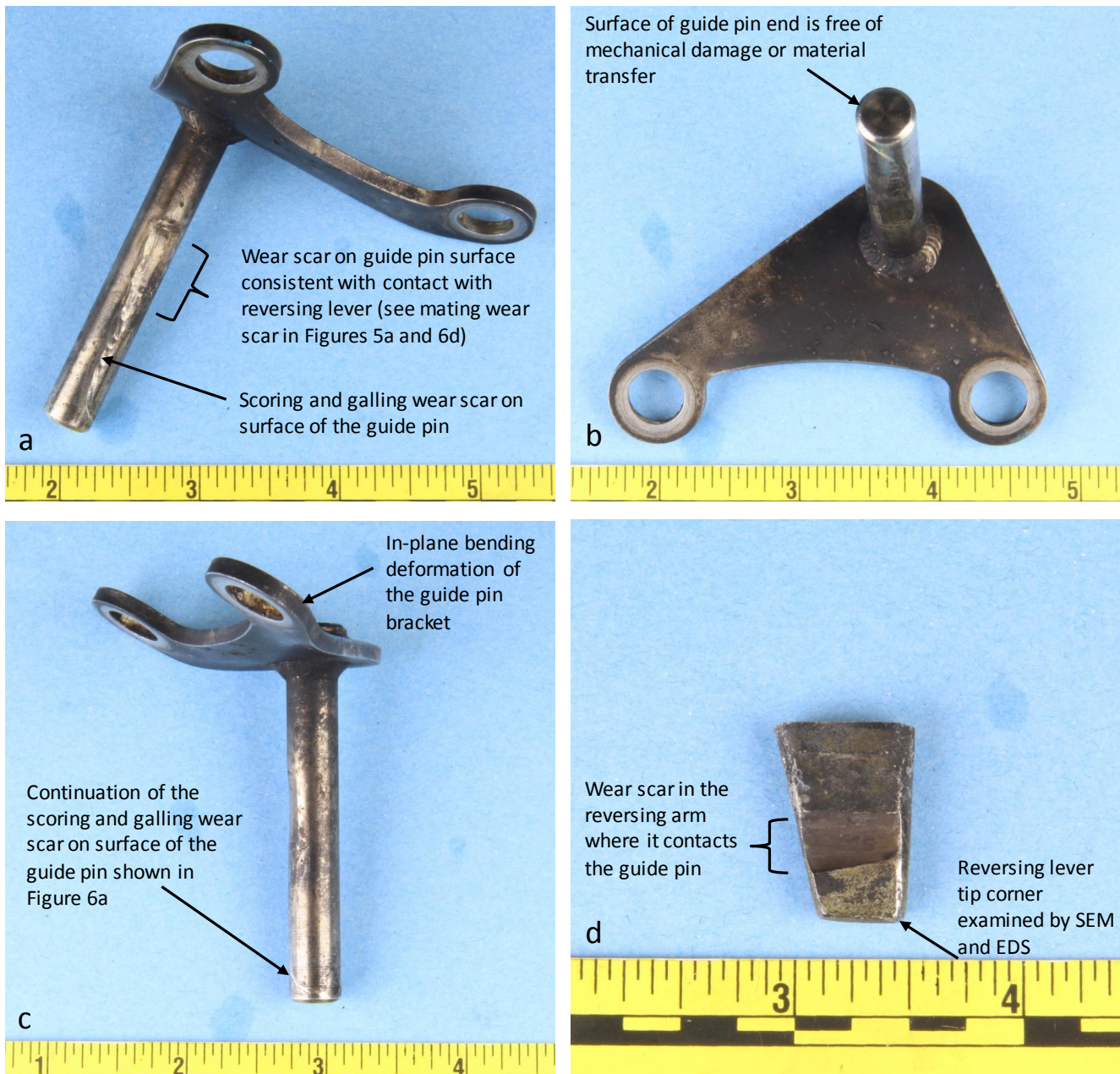


Figure 6 Images of the reversing arm tip and the guide pin and bracket assembly.

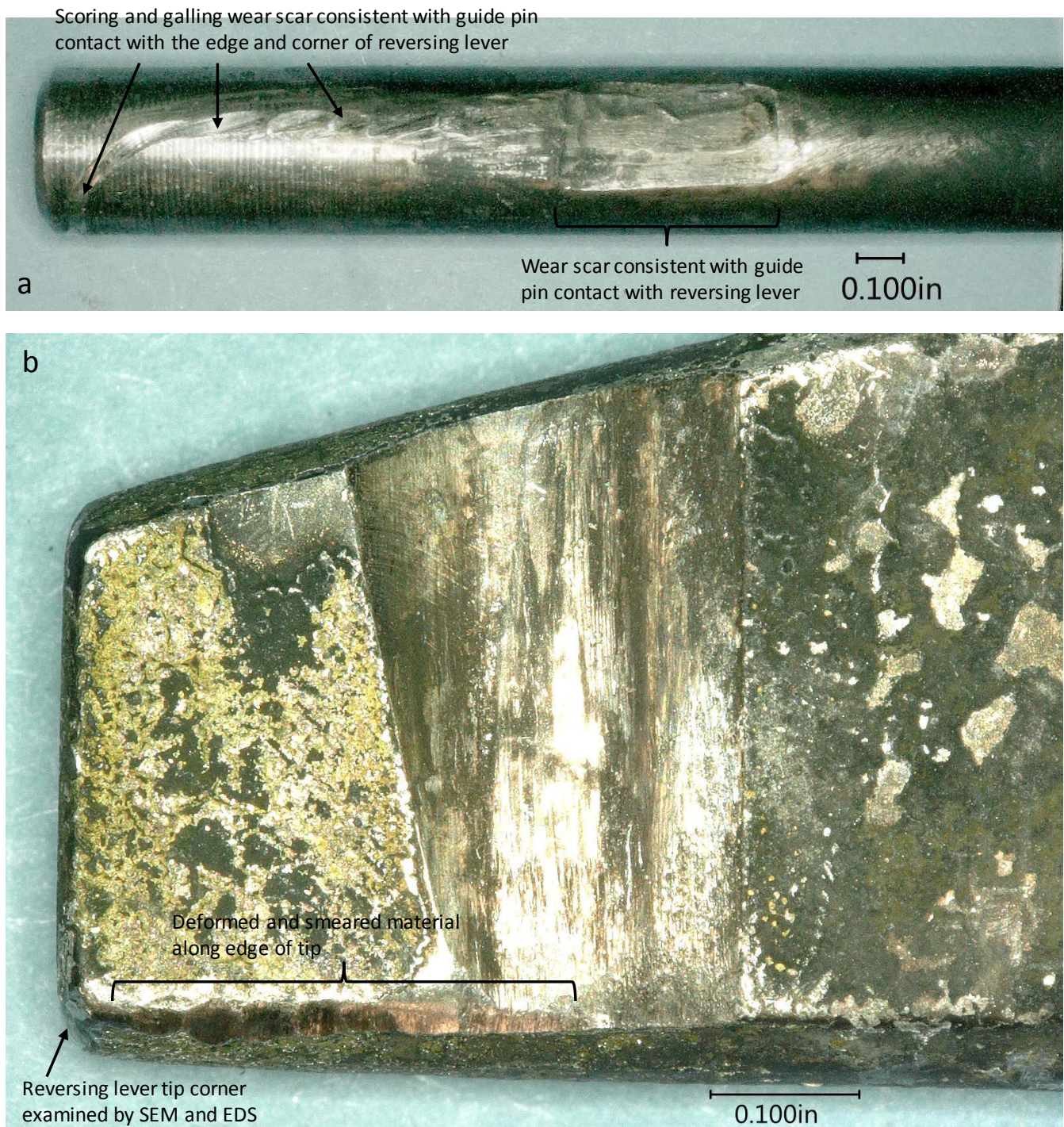


Figure 7 Images of the reversing lever tip (view b) and the guide pin surface (view a) showing the mating wear contact surfaces.

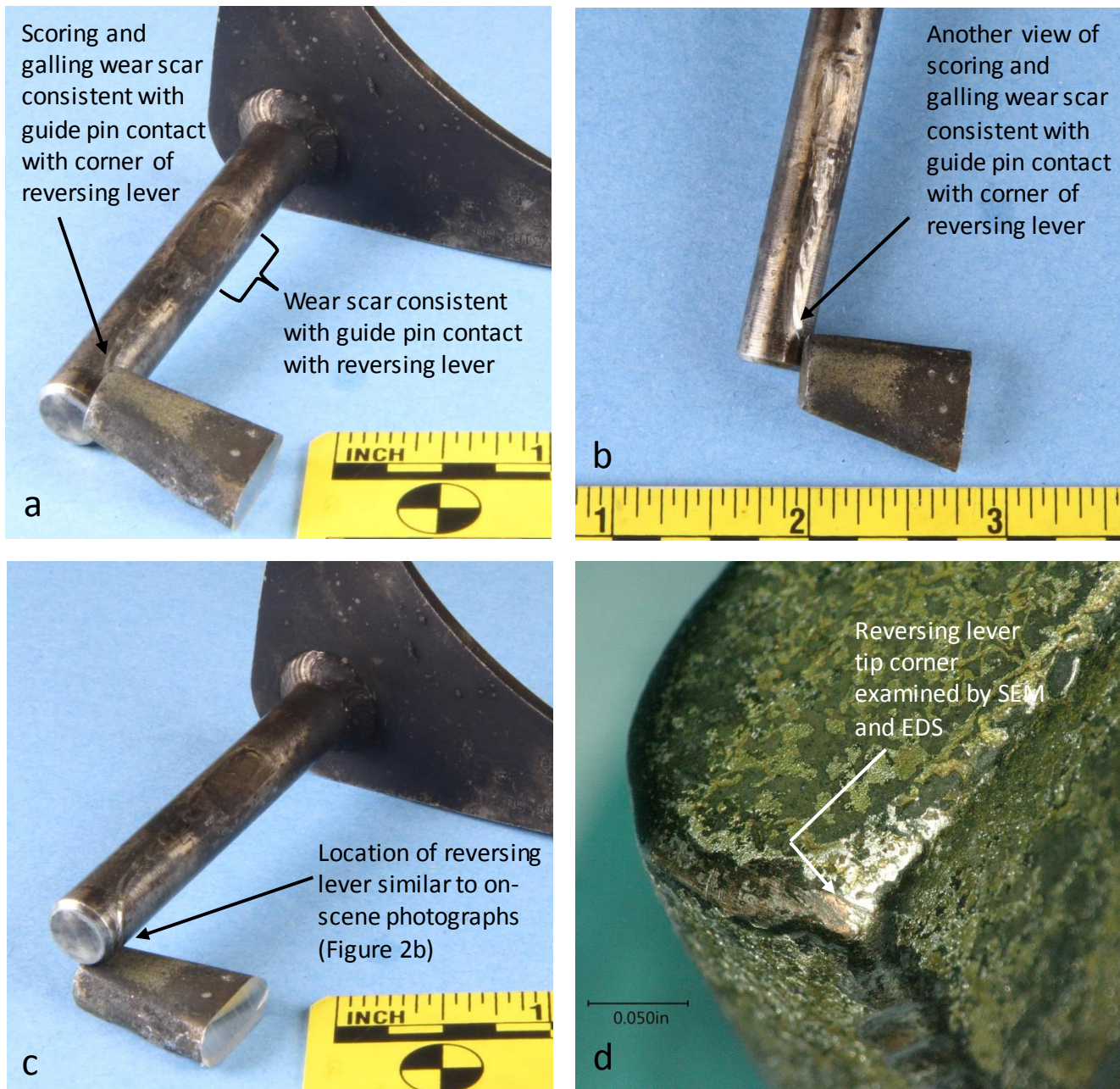


Figure 8 Images of the reversing lever tip and the guide pin demonstrating the sliding path of the reversing lever tip relative to the guide pin.

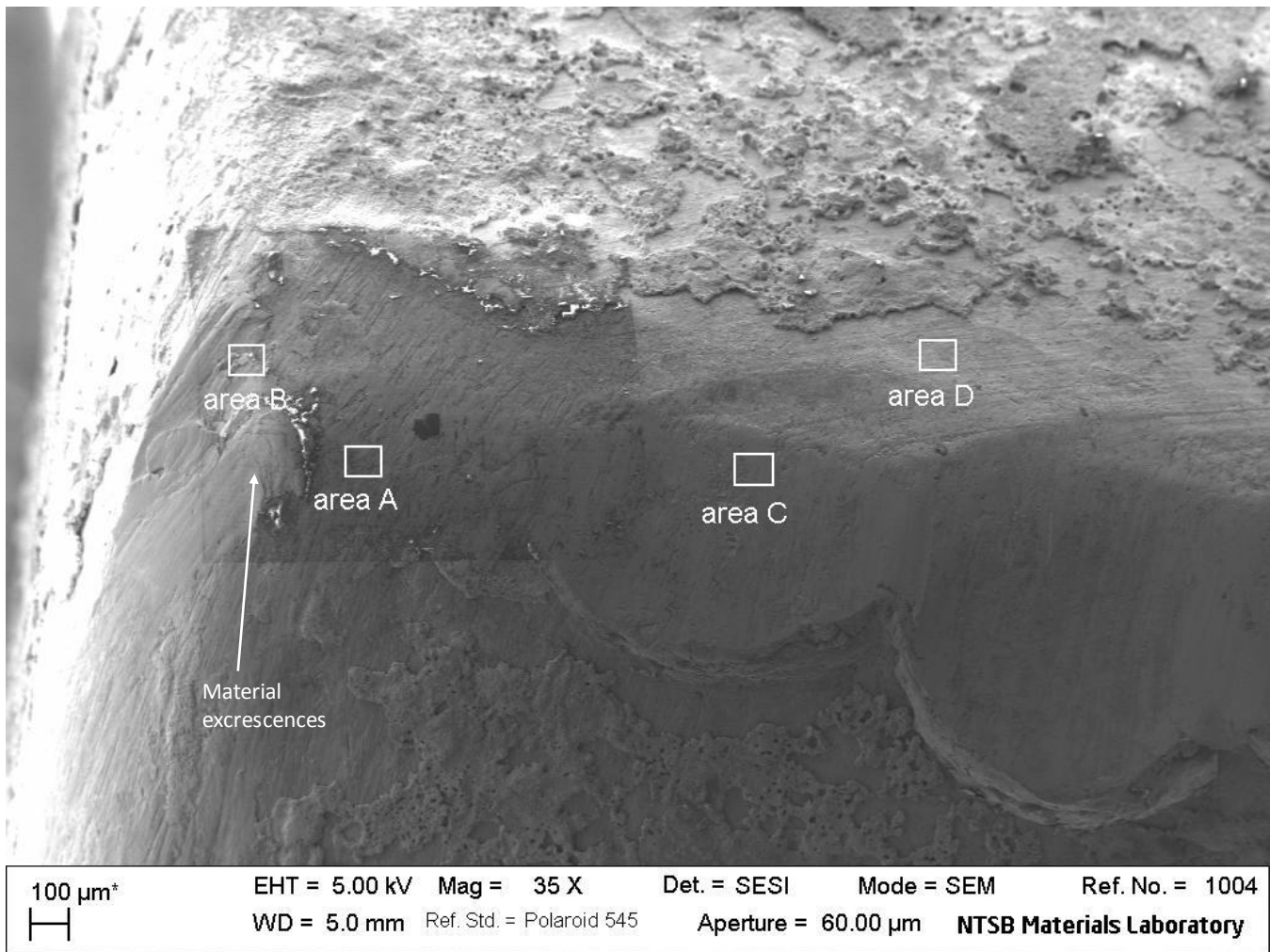


Figure 9 Scanning electron micrograph of the reversing lever tip corner (see Figure 6d, 7a, and 8d). A region exhibiting material excrescences is shown. Four areas are identified where energy dispersive spectroscopy was conducted.

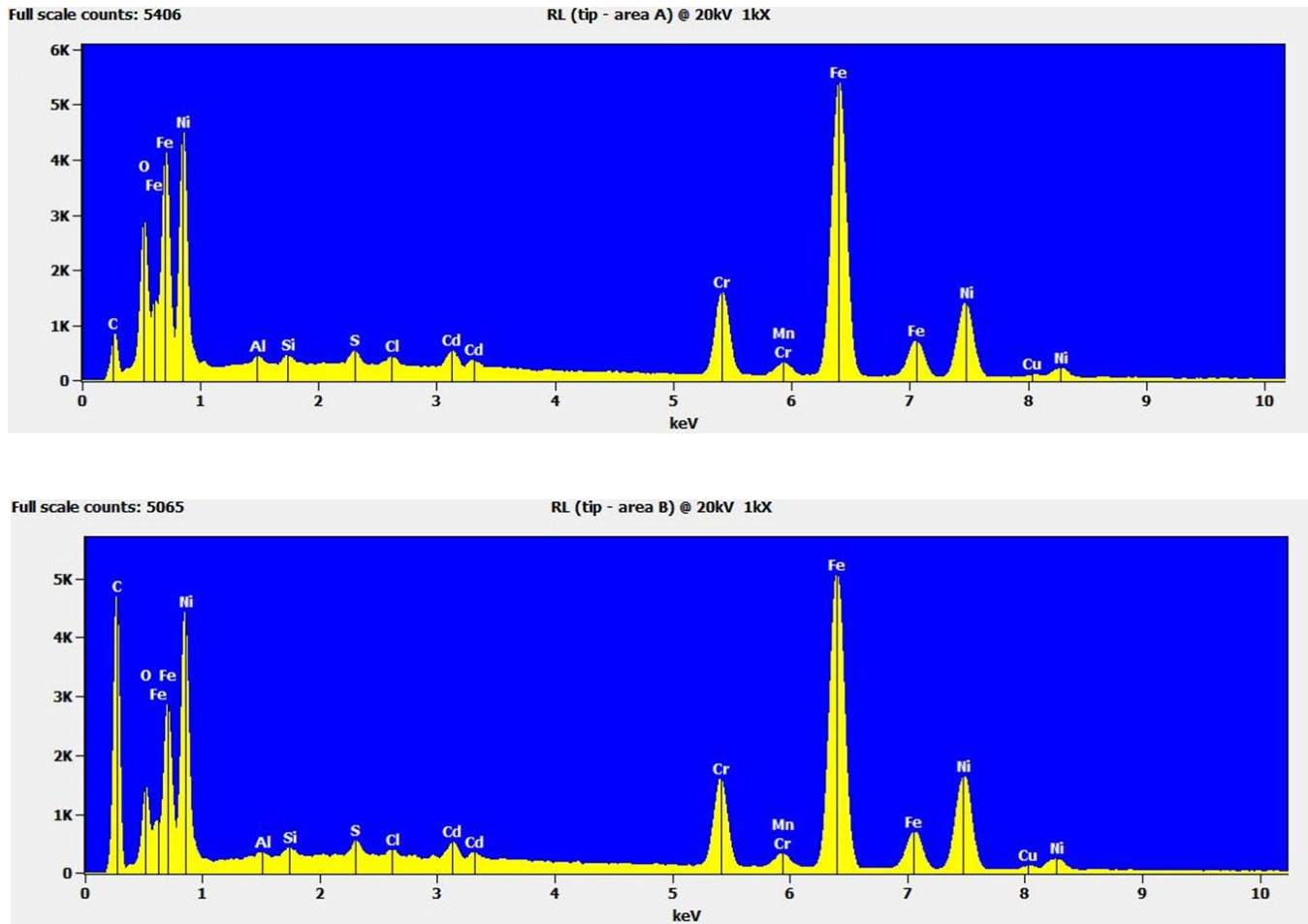


Figure 10 Energy dispersive spectra for the reversing lever tip areas a and b.

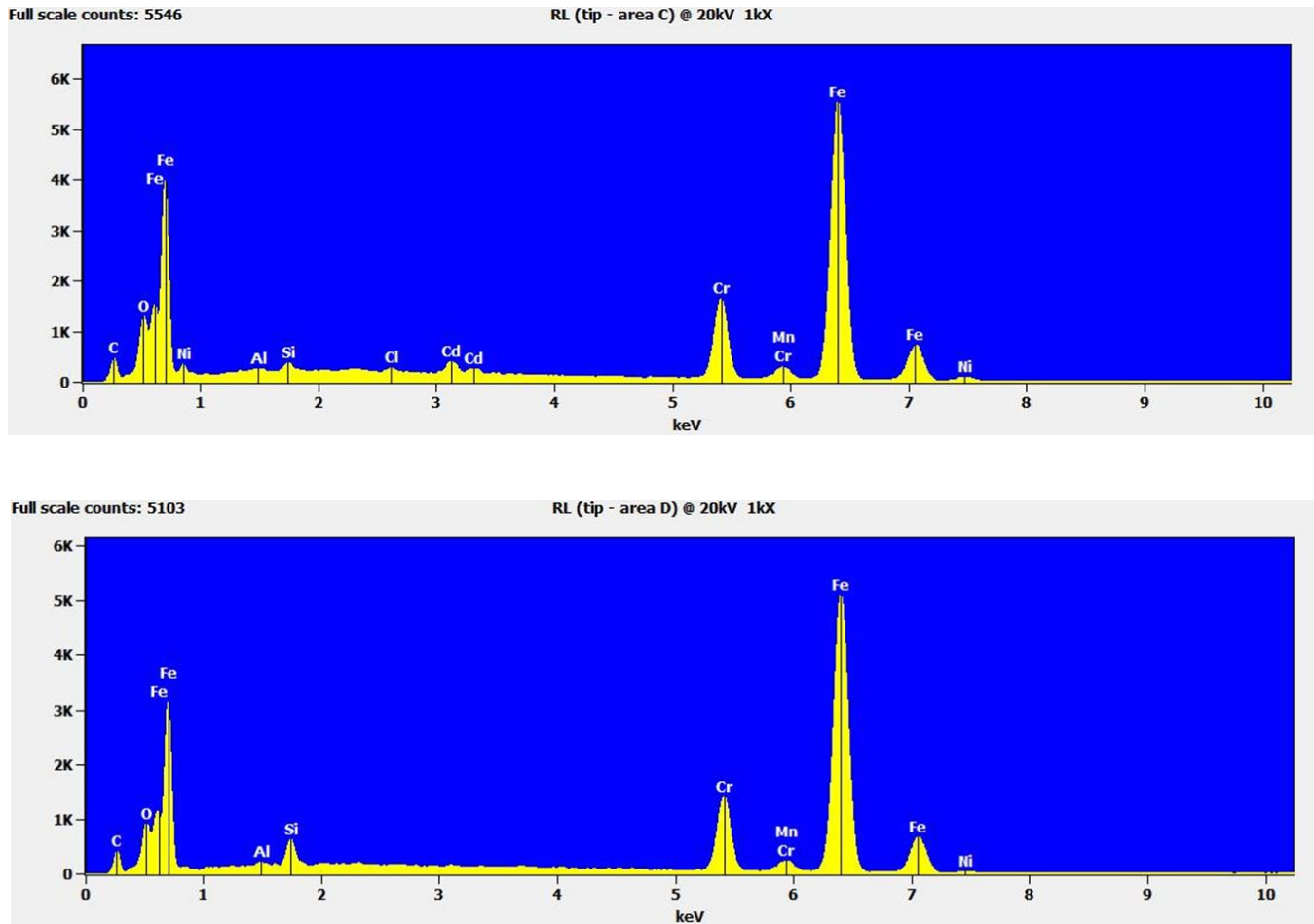


Figure 11 Energy dispersive spectra for the reversing lever tip areas c and d.

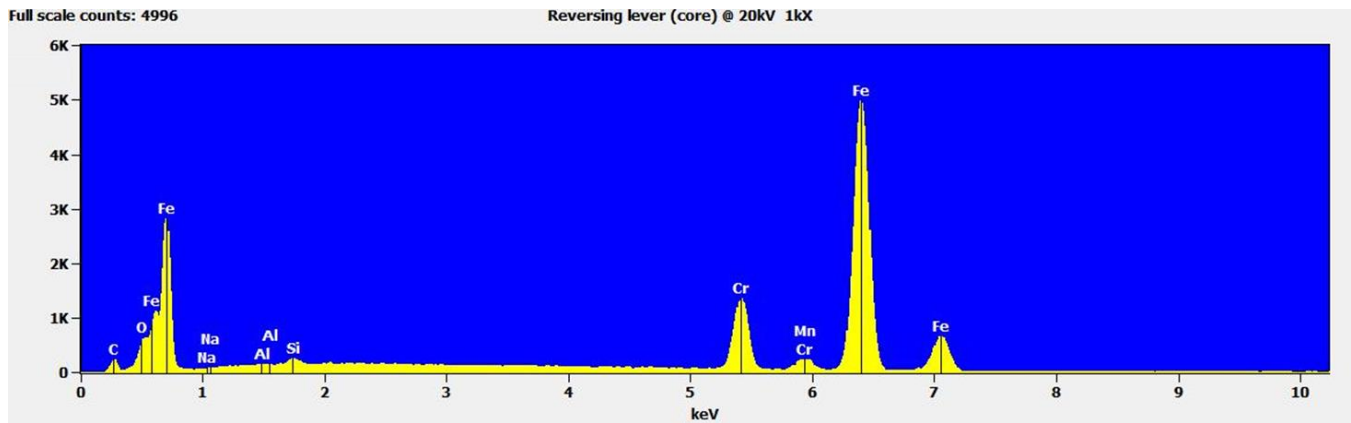


Figure 12 Energy dispersive spectra for base material for the reversing lever tip.