

NATIONAL TRANSPORTATION SAFETY BOARD

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



July 14, 2020

MATERIALS LABORATORY FACTUAL REPORT

Report No. 19-051

A. ACCIDENT

Place : Agoura Hills, CA
Date : October 23, 2018
Vehicle : North American SNJ-5 (N7969C)
NTSB No. : WPR19LA014
Investigator : Jack Vanover (AS-WPR)

B. COMPONENTS EXAMINED

1. Piston-end, master-rod piece from the #5 cylinder with a fracture through the I beam shaft

C. DETAILS OF THE EXAMINATION

The purpose of this investigation is to determine the mode of fracture which occurred at the piston end of the #5 cylinder master-rod I-beam shaft from a Pratt and Whitney R-1340-AN1 nine-cylinder radial engine. As-received images are shown in Figure 1. The orientation of the master-rod as installed in the engine was not identified upon part receipt in the Materials Laboratory.

The master-rod piece was ultrasonically cleaned in acetone. Figure 2 shows views of the cleaned master-rod piece. A close view of the fracture surface is shown in Figure 3 and in Figure 4 with annotations. As revealed in the scanning electron microscope (SEM) image in Figure 5, a fracture initiation region on the I beam shaft is present, based on fine chevron and river pattern markings near the origin region (see yellow arrows in Figure 5). The fracture surface in the immediate origin region was damaged due to mechanical contact during the failure sequence.

A higher magnification SEM image of the fracture surface adjacent to the origin region exhibited striation features typical of fatigue crack growth in hardened steel (see Figure 6).

As identified in Figure 4, the fatigue crack progressed through the I beam, terminating at the location indicated in the figure. The remaining portion of the I beam fractured in overstress (Mode 1, monotonic fracture) based on the observed microvoid coalescence (MVC) fracture features (see Figure 7).

Aphrodite Strifas
Student Trainee

Michael Budinski
Chief, Materials Laboratory

Materials Laboratory Division

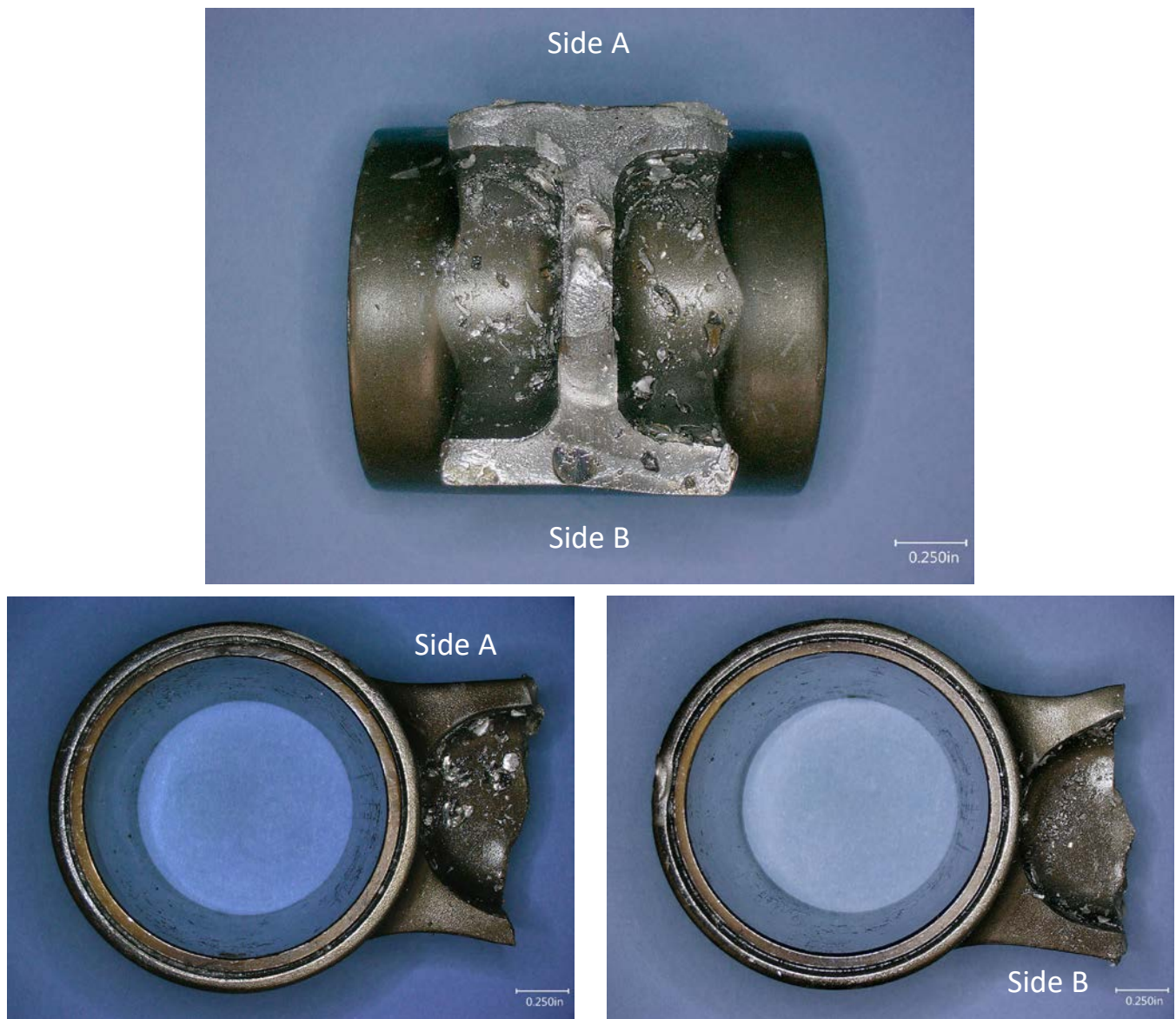


Figure 1 Digital microscope images of the fractured master rod, as-received.

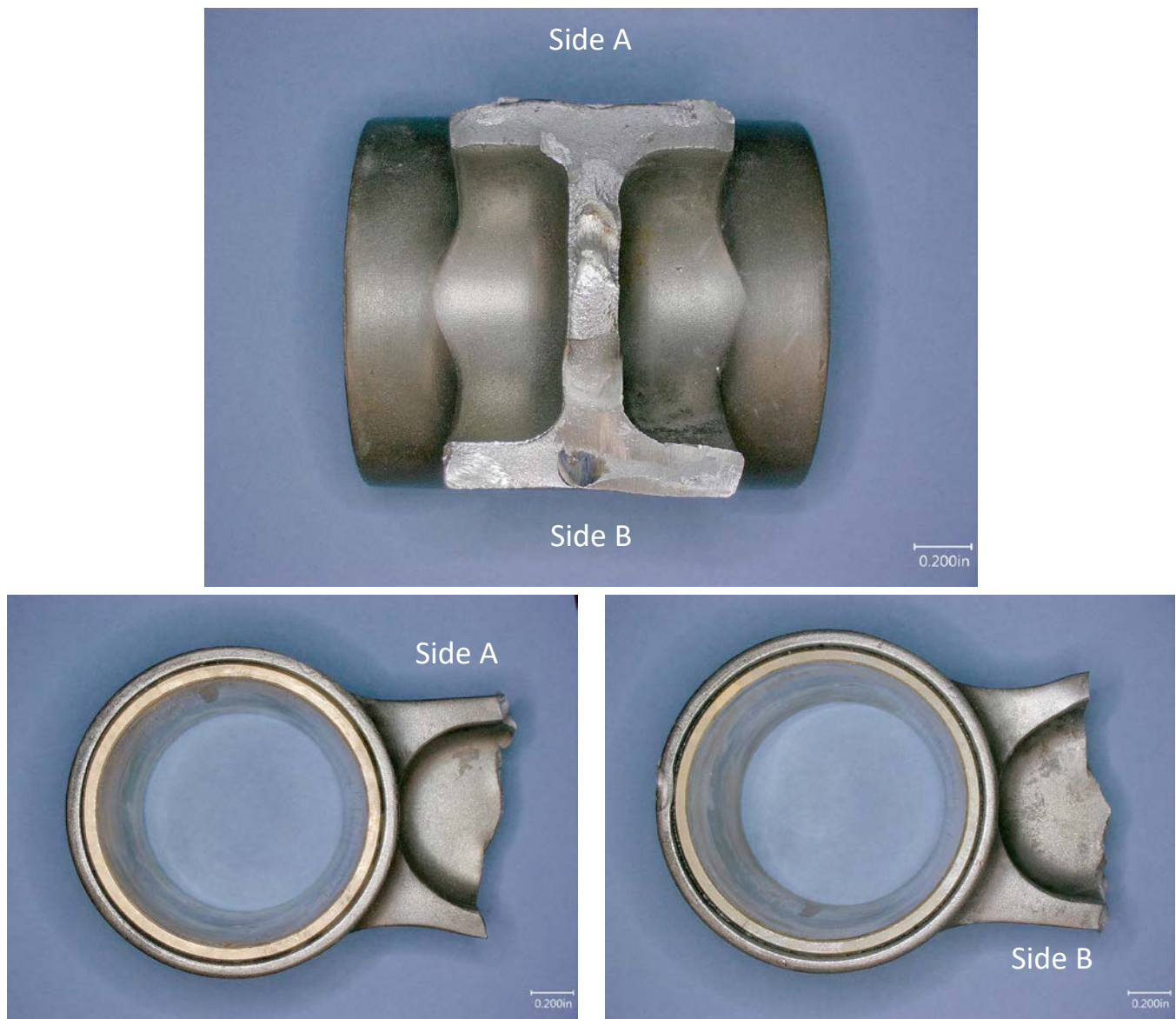


Figure 2 Digital microscope images of the fractured master rod, after cleaning.

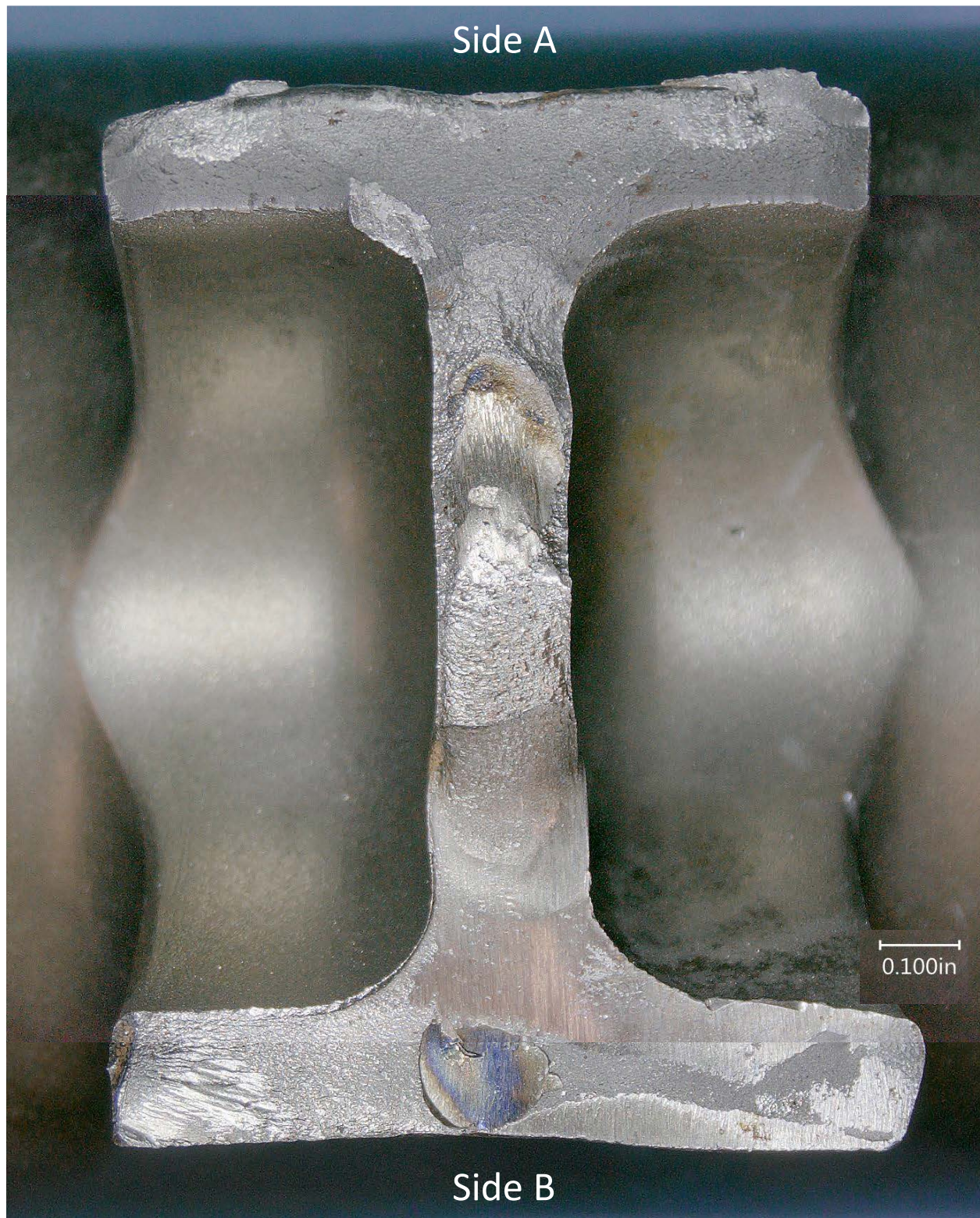


Figure 3 Digital microscope image of the fracture surface in the I beam of the master rod. The fracture surface exhibited mechanical damage over more than about 40% of the surface.

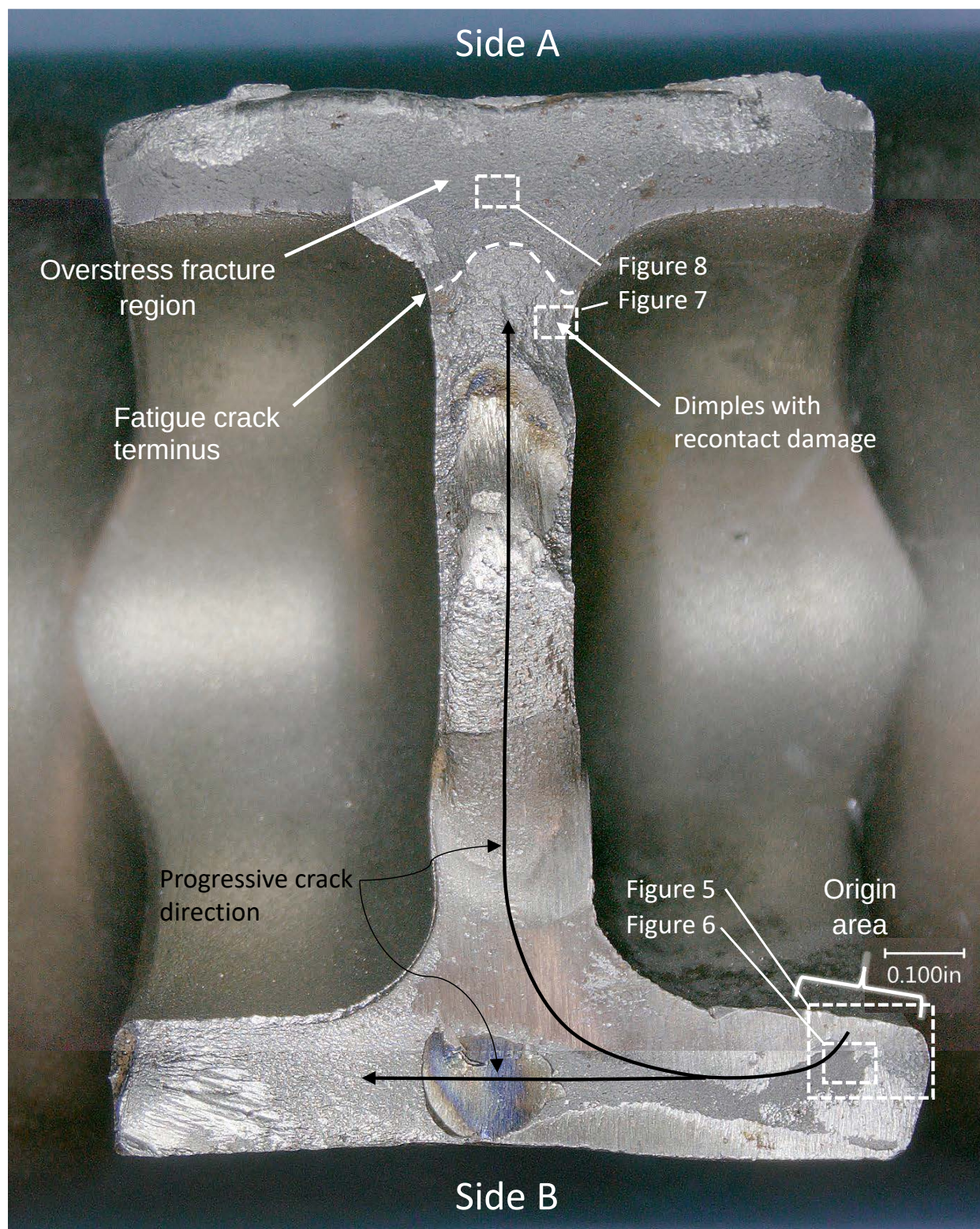


Figure 4 Digital microscope image of the fracture surface in the I beam of the master rod. This is the same image as shown in Figure 3 but with annotations of key features.

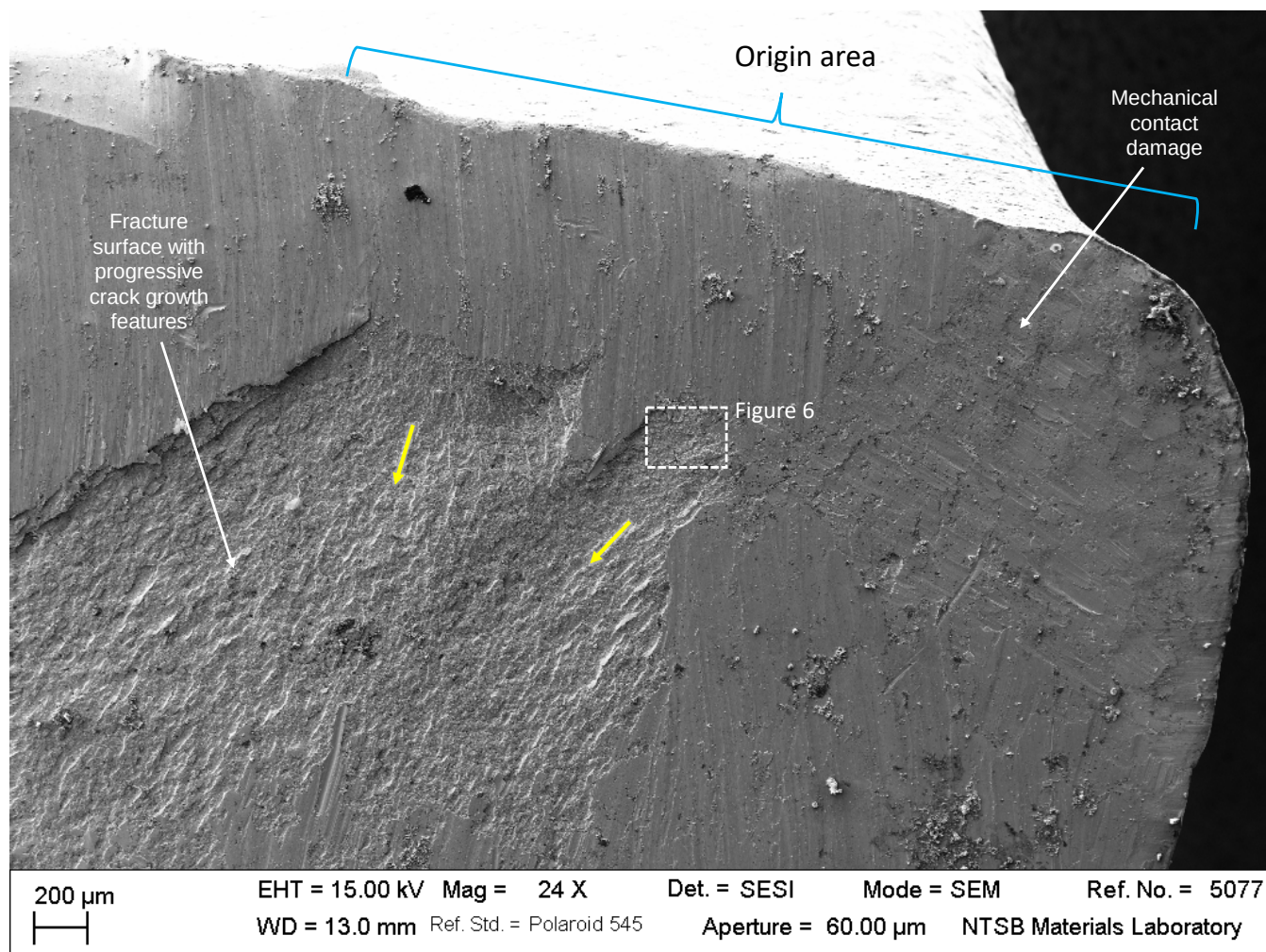


Figure 5 Secondary electron SEM fractograph of the initiation region shown in Figure 4. The yellow unmarked arrows show the local direction of growing progressive cracks. A higher magnification image of this fracture surface is shown in Figure 6.

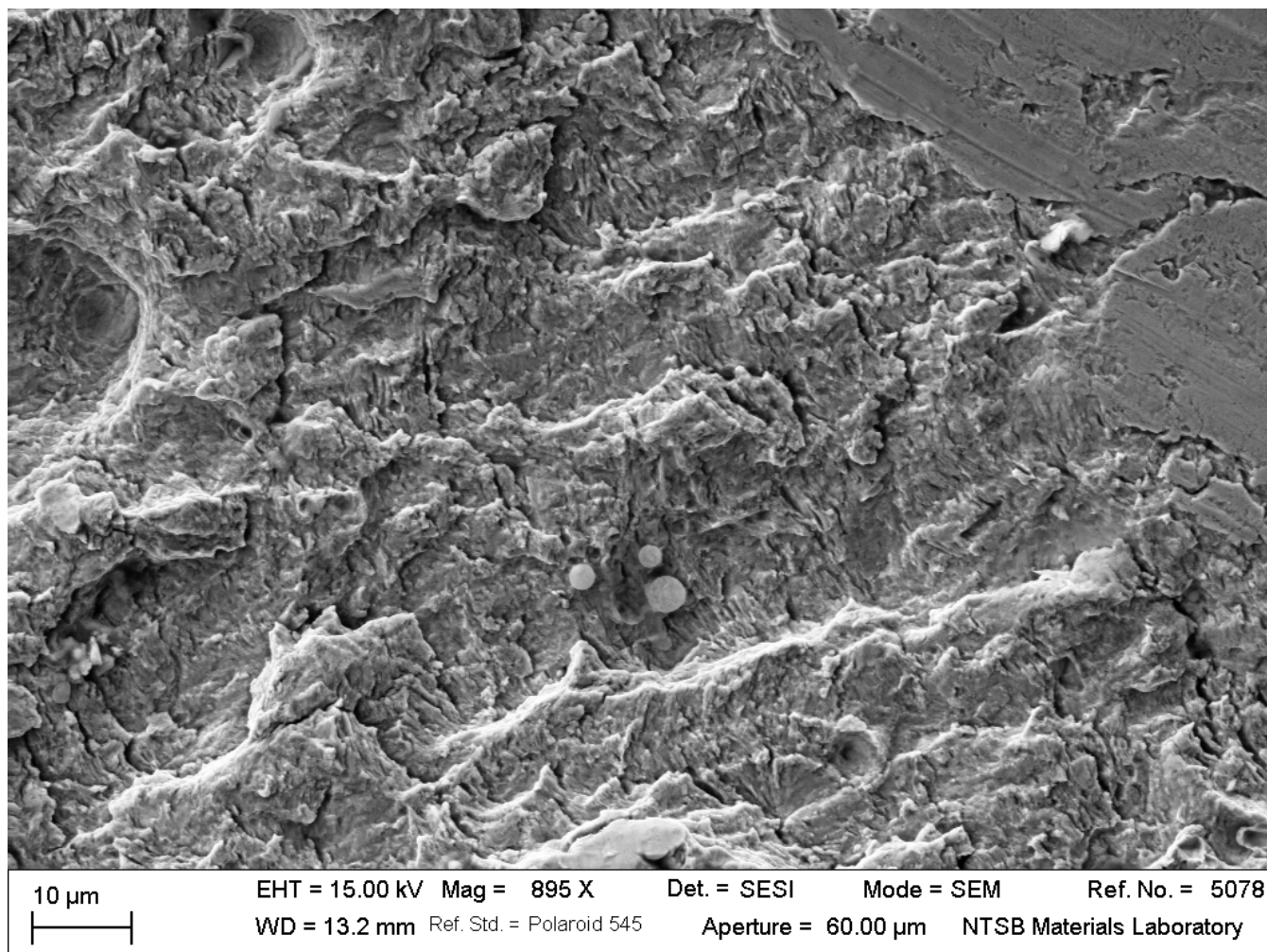


Figure 6 Secondary electron SEM fractograph of the of the region identified in Figure 5 (undamaged fracture surface adjacent to the fracture origin). Striation features consistent with fatigue crack growth are present.

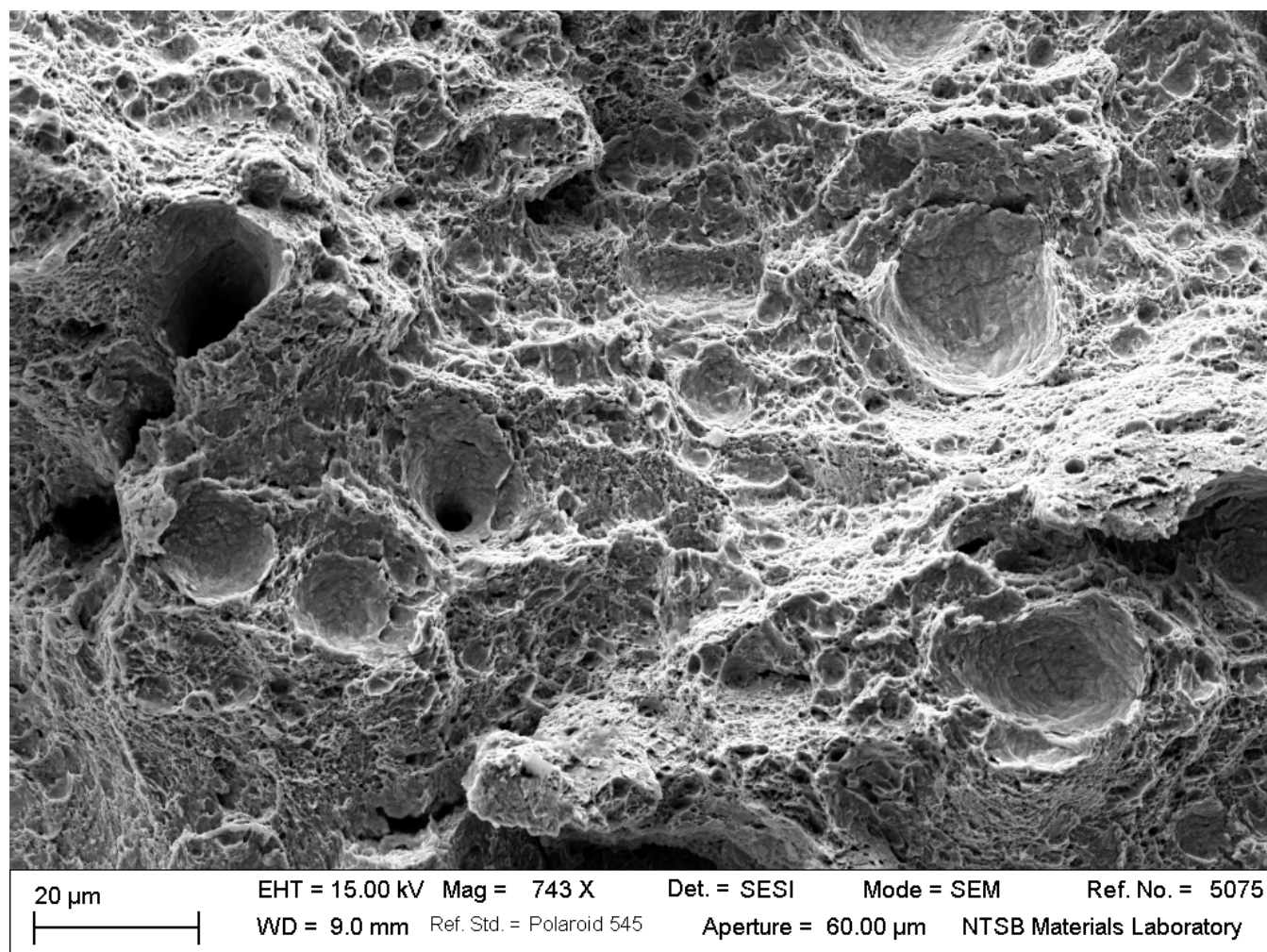


Figure 7 Secondary electron SEM fractograph of the final overstress fracture region as identified in Figure 4.