NATIONAL TRANSPORTATION SAFETY BOARD

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

August 5, 2002

MATERIALS LABORATORY FACTUAL REPORT Report No. 02-076

A. ACCIDENT

Place	: Memphis, Tennessee
Date	: February 4, 2002
Vehicle	: Airbus A300
NTSB No.	: DCA02MA001
Investigator	: Steve Magladry, AS-40

B. COMPONENTS EXAMINED

Five spring washers (four intact and one fractured into four pieces).

C. DETAILS OF THE EXAMINATION

The four intact spring washers were received in bags labeled 1 to 4. The fifth spring washer, fractured into four pieces, was labeled number 5 in the materials laboratory. An overall view of spring washer number 5 is shown in figure 1. The pieces are shown in their relative positions, labeled “a” to “d”. The washer was fractured in four locations, labeled “f1” to “f4”. As shown in figure 1, the surface of the washer had some areas that appeared optically shiny and bright, consistent with contact and rubbing. Other areas appeared dark. As indicated by red arrows in figure 1, many of the smaller dark areas appeared circular in shape, and the larger dark areas contained circular impressions, features consistent with surface pitting.

Washer number 1, shown in figure 2, has features typical of the remaining four washers. The majority of the surface did not have rubbing contact and appeared to have a relatively smooth dark surface with no evidence of pitting.

The fracture surfaces for each of the four fractures in washer 5 had similar features, as exemplified by the fracture surface on piece “d” for fracture “f3” shown in figure 3. The edges of each fracture surface were obliterated by post-fracture damage. For each fracture, all of the undamaged areas of the fracture surfaces had a granular appearance consistent with intergranular fracture. A higher magnification view of the typical intergranular features in one of these undamaged areas is shown in figure 4.

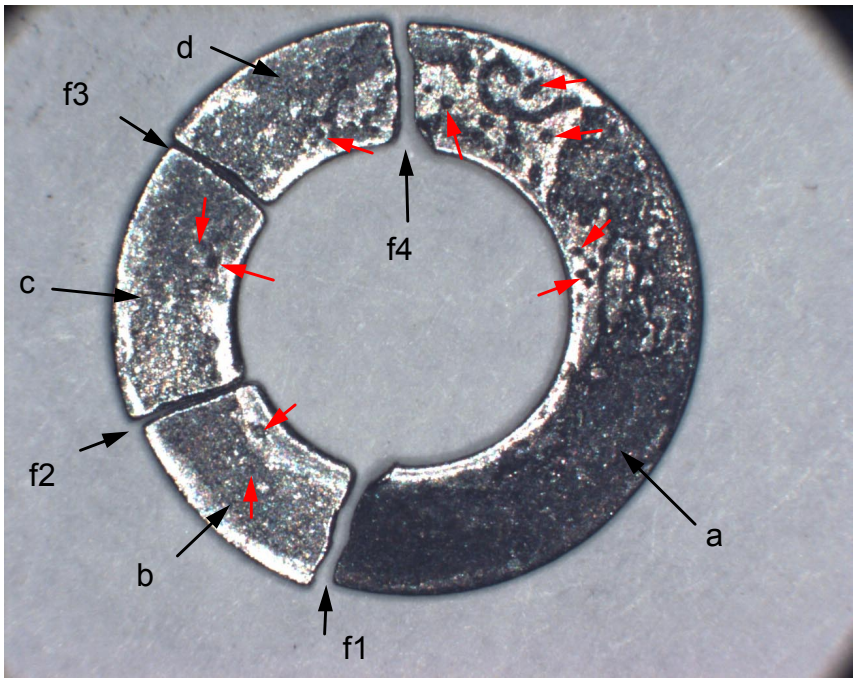
The surface of each of the washers was examined using energy dispersive x-ray spectroscopy (EDS). The spectra for the four intact washers had major peaks of iron and

smaller peaks of chromium, silicon, and oxygen. The spectra for washer 5 in areas that appeared optically dark also had a major peak of iron and a smaller peak of oxygen, but also had smaller peaks of zinc and phosphorus with no peaks of chromium or silicon.

A cross-section of washer 5, piece “c” and of washer 1 was prepared for microstructural examination. The cross-section of piece “c” near the outer edge is shown in figure 5. Prior austenite grain boundaries were observed near the edges, but not toward the center. No prior austenite grain boundaries were observed on the cross section for washer 1.

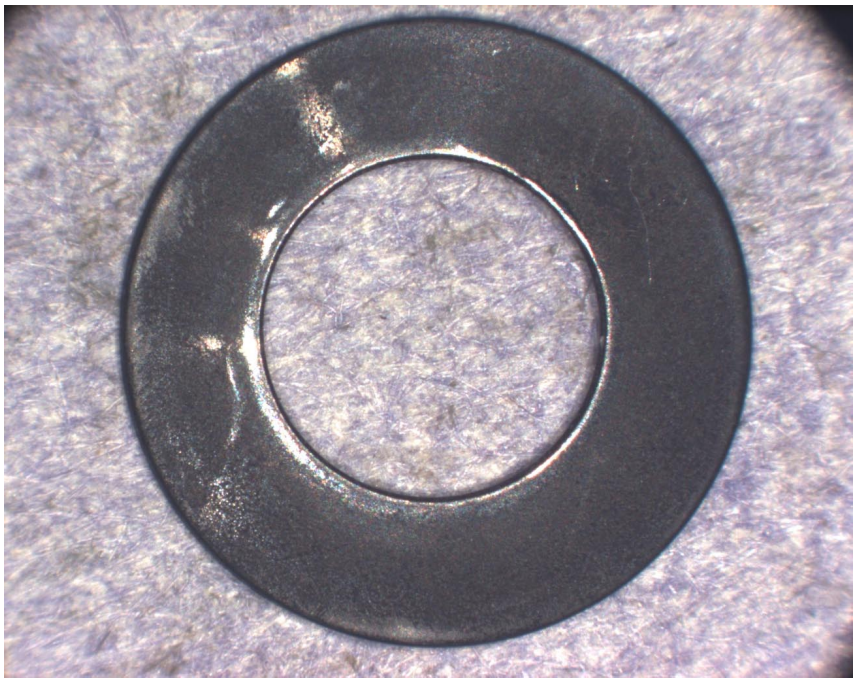
Hardnesses of washer 1 and washer 5 were measured in the cross-sections using an elongated diamond indenter with a 500-gram load. The average hardness was 49.2 HRC (526 HK) and 54.4 HRC (618 HK) for washer 1 and washer 5, respectively. According to the engineering drawings for the spring washers, the specified material is either 50CV4 or XC75. According to the manufacturer, 50CV4 is a spring steel similar to AMS 6450. The manufacturer did not provide information about XC75 as of the writing of this report. According to the AMS 6450 specifications, the hardness of the finished product should be in the range of 43 to 46 HRC.

Matthew R. Fox
Materials Engineer



ImageNo:205A0585, Project No:A00360 ⊢ 2 mm ⊣

Figure 1. Overall view of the convex side of washer 5. The four pieces, labeled "a" to "d", are shown in their relative positions. The four fractures are labeled "f1" to "f4". Unlabeled red arrows indicate some of the circular indentations indicative of surface pitting.



ImageNo: 207A0530, Project No:A00360 ⊢ 2 mm ⊣

Figure 2. Overall view of the convex side of washer 1 showing features typical of the remaining washers.

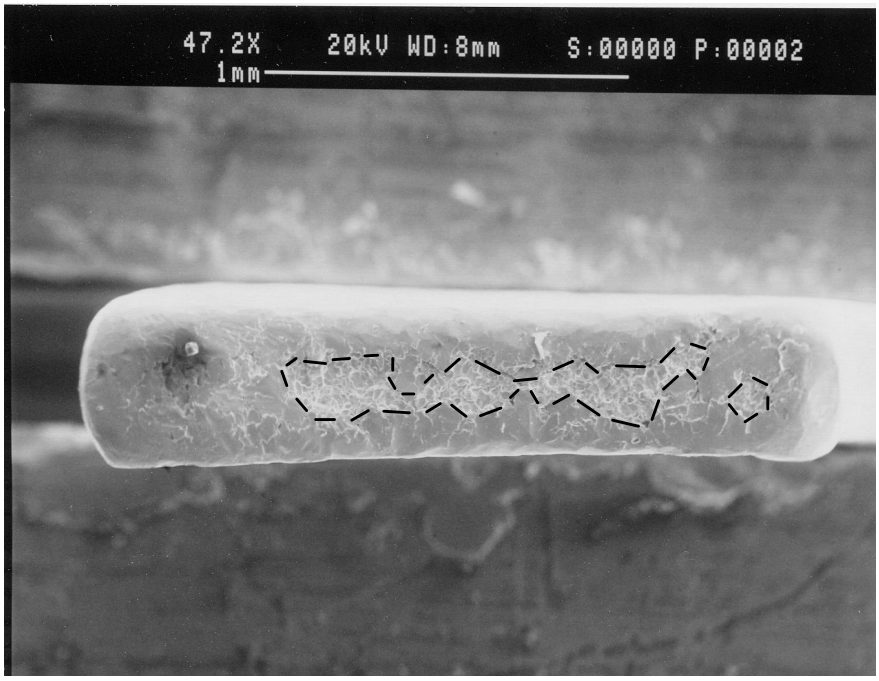


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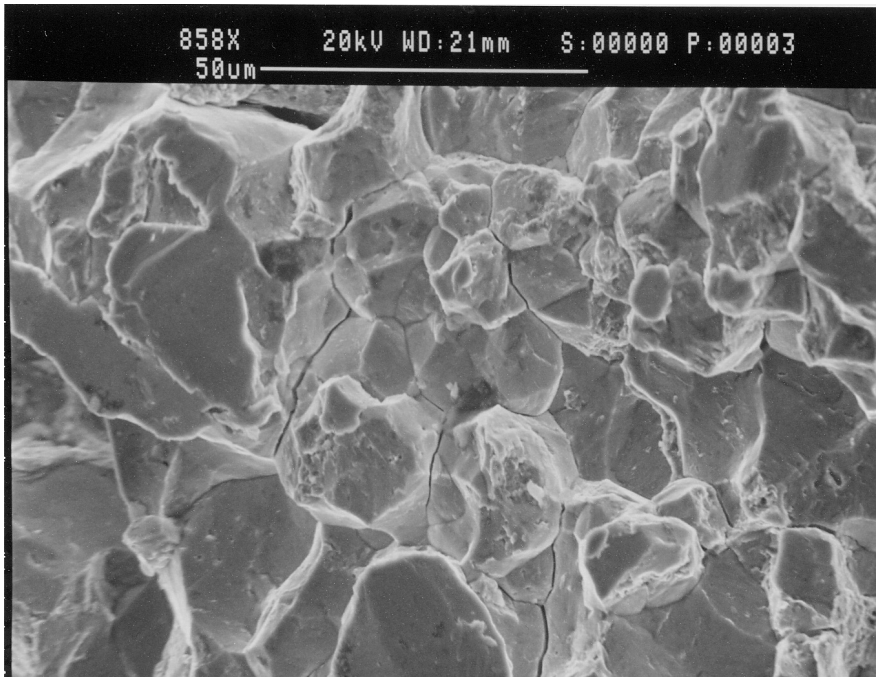
Figure 3. View of the fracture surface on piece "d", fracture "f3". Areas bounded by dashed lines indicate relatively undamaged areas with intergranular fracture features.



ImageNo: 208A0062, Project No:A00360

Figure 4. Typical intergranular fracture surface observed on undamaged areas of the fracture surfaces.

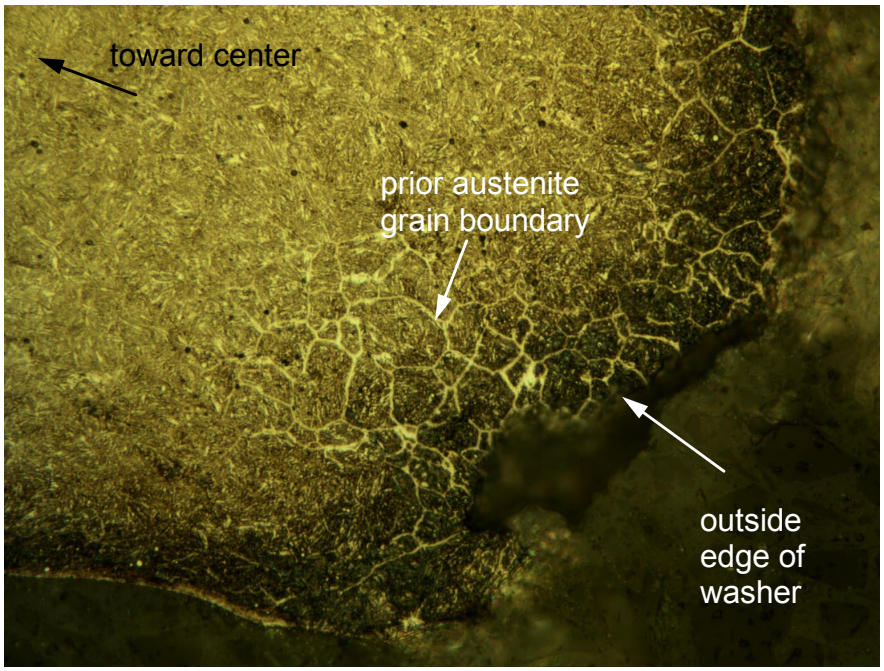


Figure 5. View of the cross-section of piece "c" showing the microstructure near the edge. Prior austenite grain boundaries (appearing light-colored in the figure) are visible near the edges, but not toward the center. (Nital etch).