doi: 10.1017/S1431927609094513
Microsc Microanal 15(Suppl 2), 2009

Failure Analysis Problem Solving Using Metallography

F. Hogue

Hogue Metallography, 15201 DePauw Street, Pacific Palisades, CA 90272

Metallography is one of the many tools available to a failure analyst. Many engineers overlook this basic and fast technique. Quite often sophisticated analysis techniques are applied when metallography is sufficient or even the only way to identify the cause of the failure. Of course an experienced metallographer is essential in order to reveal and interpret differences in microstructures.

Along with the following two examples others will be described and discussed.

Example 1: A tool made from heat treated and nitrided 440A martensitic stainless steel failed prematurely. Longitudinal metallographic sections were prepared from the failed tool and an identical one that was used for a long time without failure.

Etching with Kalling's reagent revealed a martensitic matrix and globular carbides that remained white after etching. In the failed part faint linear indications were visible in the microscope, but difficult to document (Fig. 1 & 2).

Fry's etch darkens the martensitic matrix, but the primary carbides and cementite remain light, providing good contrast (Fig. 3 & 4). Long platelets of carbides can easily be distinguished in the failed sample (Fig. 3). These platelets could be removed by re-heat treating the sample, which indicates that they were cementite plates precipitated along prior austenite gain-boundaries during improper heat treatment.

Example 2: Commercially pure TIG welded tubing in a desalination plant started to leak. Transverse sections were prepared through a location close to the failure location and also in an area that appeared unaffected.

Considerable thinning on the I. D. is evident in the weld zone (Fig.5). The I.D. of the tubing shows a very thick, dark layer of Ti-hydride (Fig. 6). Hydrogen in titanium migrates preferentially to irregularities in the structure, such as the weld. The Hydride is very brittle and spalls off easily if enough thickness is achieved. Fig. 7 shows black hydride needles in the weld close to the outside. Even in the non exposed areas a high amount of hydrogen is present in the form oh black needles that are only visible in the etched condition (Fig. 8).

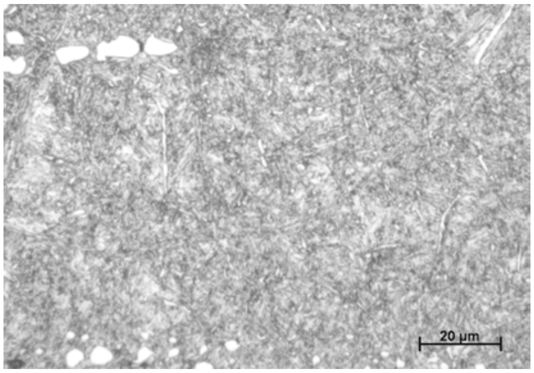

Fig. 1 Failed Kalling's Etch 1000x

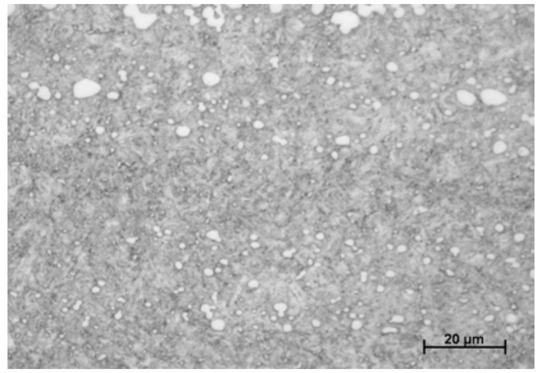

Fig 2 Good Kalling's Etch 1000x

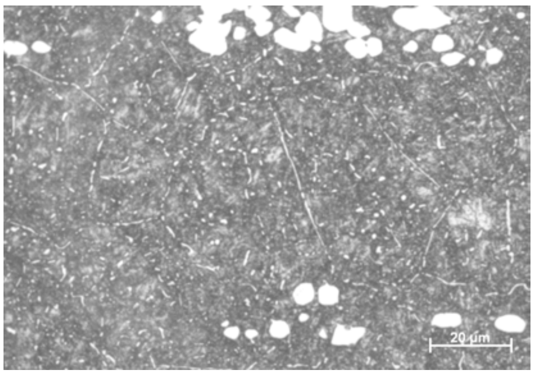

Fig. 3 Failed Fry's Etch 1000x

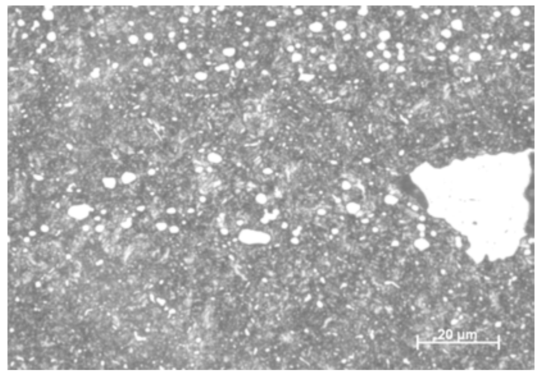

Fig. 4 Good Fry's Etch 1000x

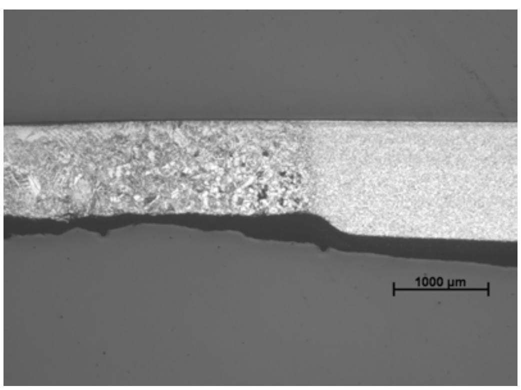

Fig. 5 Weld Kroll's Etch 25x

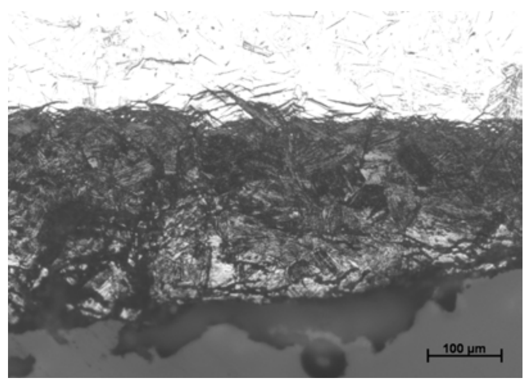

Fig. 6 Hydride Needles Kroll 200x

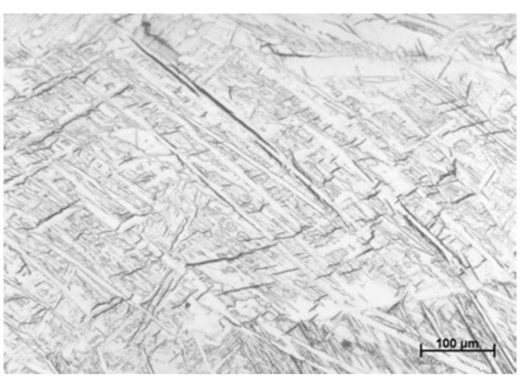

Fig. 7 Hydride Needles in Weld 200x

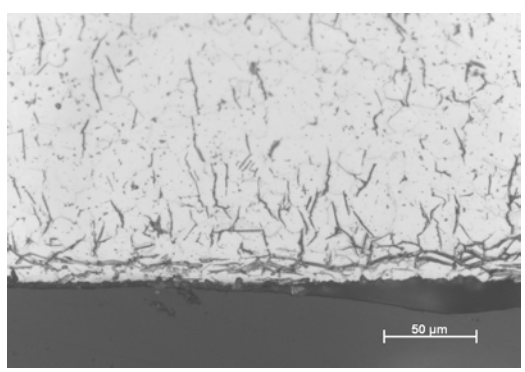

Fig. 8 Hydride in Unexposed Material

https://doi.org/10.1017/S1431927609094513 Published online by Cambridge University Press