

Hardness Profile Determination in Decarburized Steel

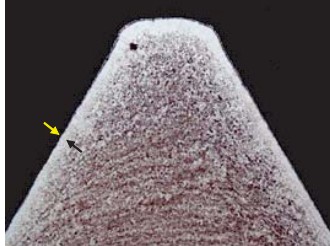
LECO Corporation; Saint Joseph, Michigan USA

Instrument: AMH55 with LM248AT (w/10X and 50X Objectives)



Decarburization

Decarburization can be defined as a loss of carbon from the surface of a metal (especially steels and cast irons) as the result of heating in a medium that reacts with the carbon atoms.



Fastener Thread Exhibiting Decarburization (100X)

While "Case Hardening" refers to a process by which the surface layer of iron-based alloys is substantially harder than the interior, the opposite occurs during decarburization. The surface of decarburized steel is SOFTER than the core, resulting in poor wear-resistance and low fatigue life. Many times it is necessary to quantify the degree of decarburization.

Sampling and Specimen Preparation

Sample Identification: Heat Treated Steel Fastener

Sectioning:

Saw MSX255M2
Blade 12" x 0.062", Rubber Bonded, Aluminum Oxide (811-089-010)

Mounting:

Press PR-36 with 1.5" Mold Assembly
Media Black Epoxy (811-645)

Grinding/Polishing:

GRINDING	Time (Minutes: Seconds)	Head Direction	Head Pressure (Pounds)	Wheel Direction	Wheel Speed (FPM)
SS-1000 Grinder/Polisher (8" Wheel)					
Platinum #1 812-341 / Water	2:00	CW	40	CCW	300

PRE-POLISHING	Time (Minutes: Seconds)	Head Direction	Head Pressure (Pounds)	Wheel Direction	Wheel Speed (FPM)
FAS Magnetic System 8" (812-381)					
Silver Disk, 6µm Cameo Suspension, Microid Extender, 812-344, 812-356, 811-003	2:00	CW	40	CCW	200

POLISHING	Time (Minutes: Seconds)	Head Direction	Head Pressure (Pounds)	Wheel Direction	Wheel Speed (FPM)
3µm Diamond Paste, Ultra Silk, Microid Extender, 810-872, 812-437, 811-003	3:00	CW	40	CCW	200
1µm Diamond Paste, Red Felt, Microid Extender, 810-870, 810-647, 811-003	1:00	CW	35	CCW	200

Etching: 2% Nital Solution
Approximately 15 seconds

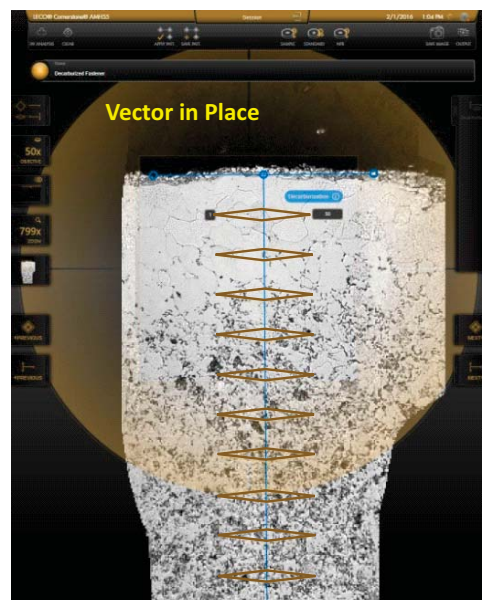
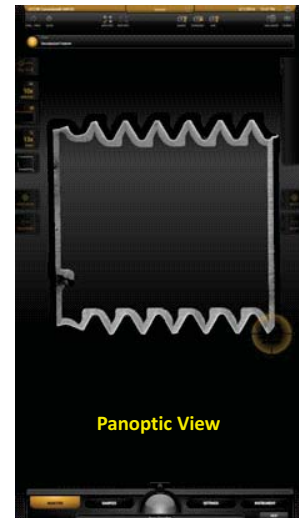
Hardness Tester Calibration Samples

Verification of the tester is performed using a certified microindentation hardness standard from LECO, NIST, or other suitable source. The hardness standard should be certified with the same load and indenter type as the sample analysis, and have a hardness value close to that of the material being analyzed.

Application Parameters – Single "Vector" / Pattern

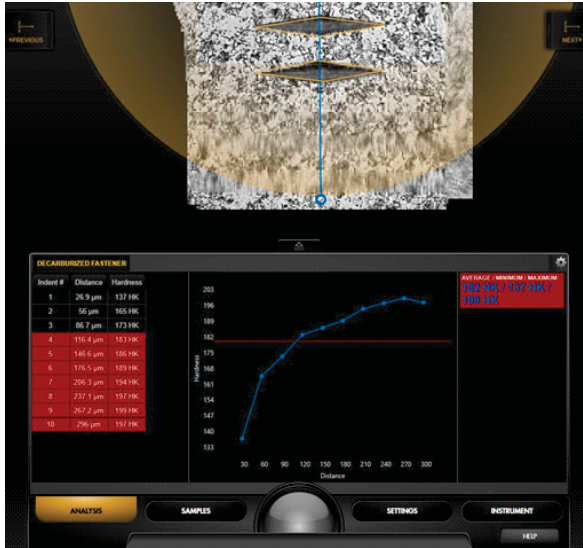
To locate an appropriate hardness test location, an auto-trace can be automatically performed using the AMH55 software. This creates a Panoptic Image, like that shown on the right.

A "vector" consisting of ten equally spaced Knoop indentations is created and dragged to the tip of one of the threads (see image below).



Application Parameters (continued)

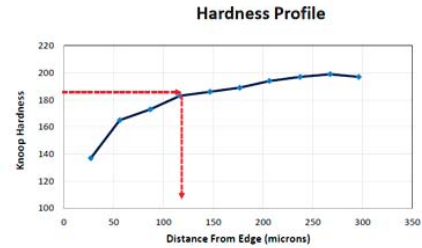
Indentations are made and measured automatically, yielding the following data:



Data from the AMH55 can be easily exported to a spreadsheet to create a custom report.

Name	Description
Decarburized Fastener	100 Gram Knoop

Indent #	Distance (µm)	Hardness
1	27	137
2	56	165
3	87	173
4	116	183
5	147	186
6	177	189
7	206	194
8	237	197
9	267	199
10	296	197



The hardness is lowest at the surface (lowest carbon content) and gradually increases toward the core. In some cases a hardness limit is calculated based on the surface and core hardness values, and is used to define the depth of the decarburized layer. In the above example, the limit of the decarburized layer is defined as the point at which the hardness has increased to 75% of the core value. The core hardness was measured as 197 HK and the surface hardness was 137 HK. Seventy-five percent of the difference (60) is 45; so the limit is calculated as 182 HK (137 + 45), giving a decarburized layer of approximately 110 microns (0.11 mm).