

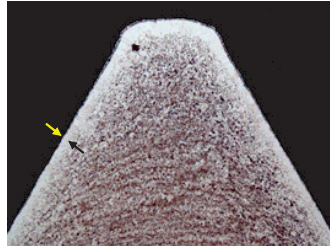
**Instrument: AMH55 with LM248AT (w/10X and 50X Objectives)**

## Decarburization Depth Analysis Using Microindentation Hardness Testing

LECO Corporation; Saint Joseph, Michigan USA

### 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. For this reason, it is important to know the depth of decarburization in a material. Microindentation hardness testing is an excellent method to quantify the material hardness at precise depths.

### 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 MX400 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)
PX400 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, 6 μm 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)
3 μm Diamond Paste, Ultra Silk, Microid Extender, 810-872, 812-437, 811-003	3:00	CW	40	CCW	200
1 μm Diamond Paste, Red Felt, Microid Extender, 810-870, 810-647, 811-003	1:00	CW	35	CCW	200

**Etching:**

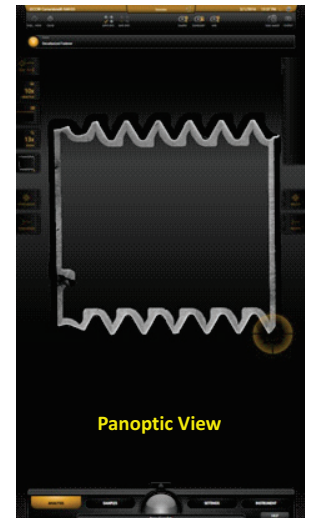
2% Nital Solution  
Approximately 15 seconds

### 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.

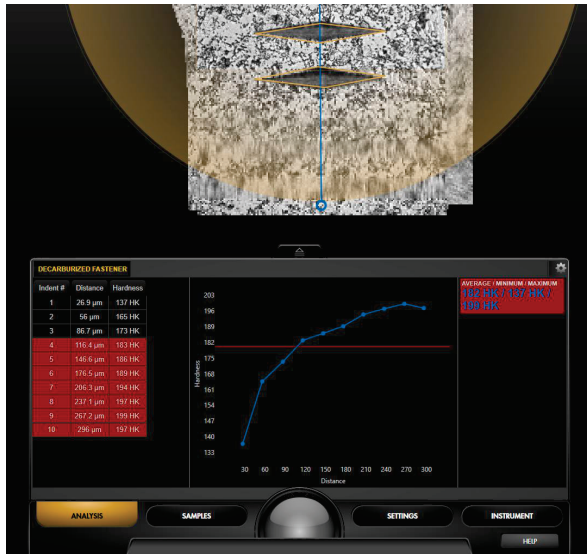


A "vector" consisting of ten equally spaced Knoop indentations is created and dragged to the tip of one of the threads (see image below).



## Application Parameters (continued)

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

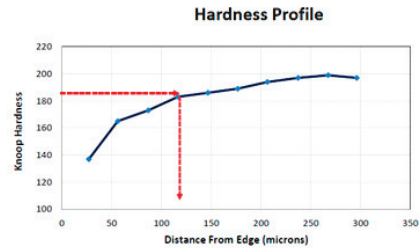


Data from the AMH55 can be easily exported to a spreadsheet to create a custom report.

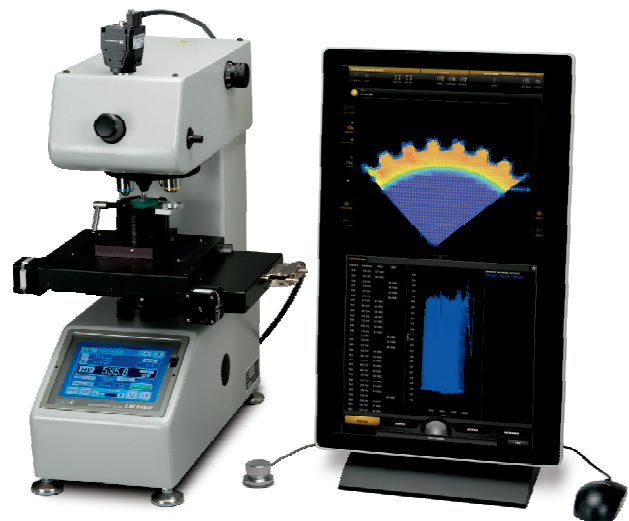
Name	Description
Decarburized Fastener	100 Gram Knoop

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 was defined as the point at which the hardness was 75% of the difference between the core and surface values. 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 was calculated as 182 HK (137 + 45), indicating a decarburized layer of approximately 110 microns (0.11 mm).



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