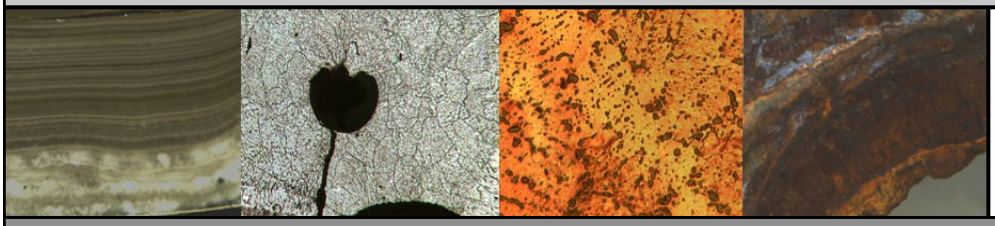
NUTS & BOLTS



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Your Problem Solving Partner

Welcome to New Hampshire Materials Laboratory

In this Nuts and Bolts article, we dive into the world of heat treatment, heat treatment verification and how NHML can help you find out if your materials or products meet industry specifications. This process and testing procedures can be very important for a number of industries of both suppliers and consumers.

For more information or to find out more on how we can be "Your Problem Solving Partner", please visit our website at www.nhml.com or call our toll free number 800-334-5432.

Tim Kenney
CEO/Laboratory Director

Heat Treatment Verification

By: Timothy Kenney

Metals and alloys are heat treated in order to alter their mechanical properties. The Heat Treatment process is a method by which metals are heated and cooled within a controlled environment. Through this process the metals being treated are made more useful by either altering or restoring their mechanical properties. The metal can be made harder and stronger or it can be made softer and more ductile depending on the need of the intended user. As there are numerous types of heat treatment techniques, there are also numerous ways of verifying that the heat treatment produced the desired results.

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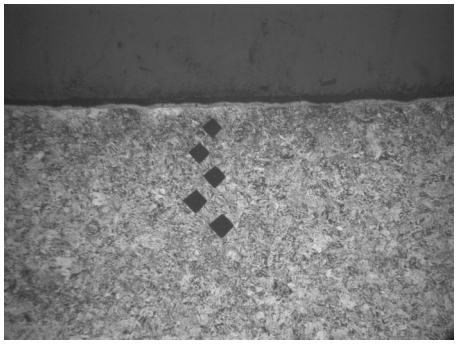
At NHML, we analyze heat treated specimens in a couple of different ways. One method is by mechanical testing. This testing is the best way to ensure that the material is performing to the heat treatment specifications. Mechanical testing helps reveal the true mechanical properties whether is it by tensile testing, hardness testing or any other mechanical test we are capable of conducting, and these tests provide real usable data.

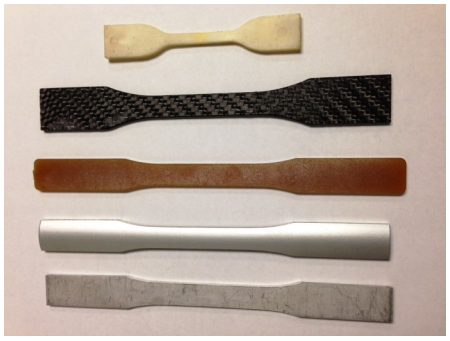
In a heat treatment situation, the simplest verification of a heat treatment would be a hardness test. Hardness testing provides rapid results and requires a minimal capital investment. Heat treatment specifications usually state a desired final hardness and this testing can be used to determine if the material has been properly softened (annealed or normalized) or hardened (quenched and tempered, or precipitation hardened).



Example of a microhardness traverse of a carburized sample at 100x

If specific mechanical properties need to be verified, tensile testing will be required. Tensile testing can be used to determine yield strength, tensile strength, elongation and reduction in area. Tensile specimens can be fabricated from the heat treated part or from separate test bars of the same material which were also heat treated with the parts.

Example of Tensile Rounds machined for tensile testing of materials



Example of Tensile Flats machined for tensile testing of materials

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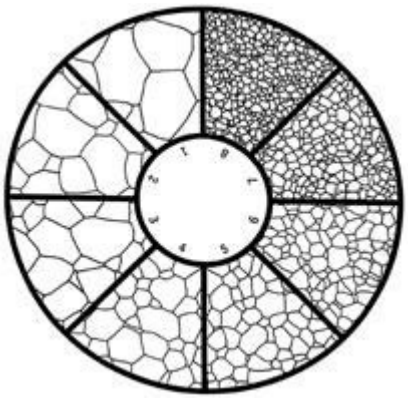
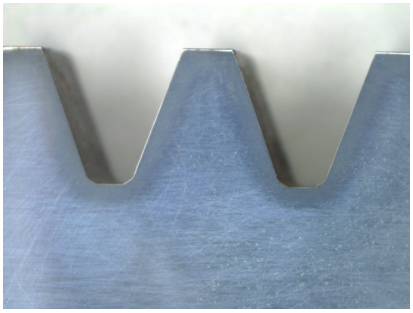


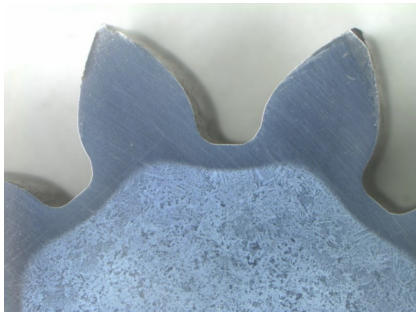
Grain Size Comparison Chart

Along with the mechanical testing, verification of the heat treatment may also require the preparation of metallographic specimens for examination by optical microscopy. By doing this, we are able to characterize the microstructure of the specimen. Metallography, in the most basic sense, consists of the selection and preparation (sectioning, mounting, grinding, polishing and etching) of specimens for microscopic examination. The appearance of the microstructure will allow us to better understand the material and its mechanical behavior. Microscopic examination is also used to determine the grain size of annealed materials and to also determine if the annealing was uniform. The relative amounts of the phases in multi-phase alloys can also be determined by metallographic examination.

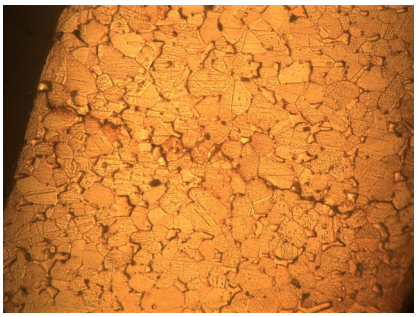
Case hardened parts may require a visual examination to determine an overall case depth or a microhardness traverse to determine effective case depth. Effective case depth is typically defined as the distance from the surface of the part to the hardness limit, usually where the hardness is equivalent to Rockwell C 50.



A carburized case showing uniform depth of hardening 7x



Example of induction hardened gear showing the case extending past the roost of the teeth 7x



Example of a brass sample etched to show grain size 400x

Example of stainless steel etched to show hardened surface layer 500x

***Further photo examples on the following page.

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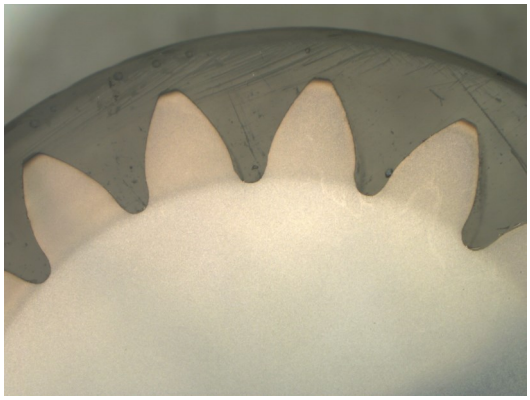
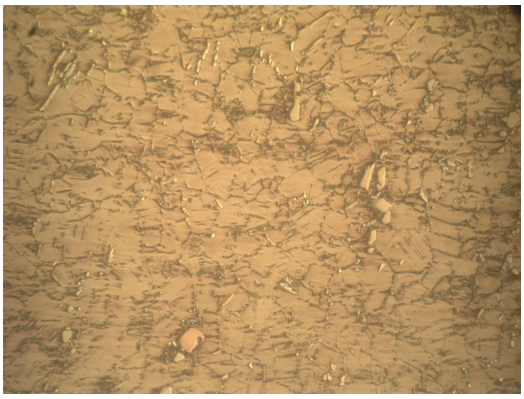
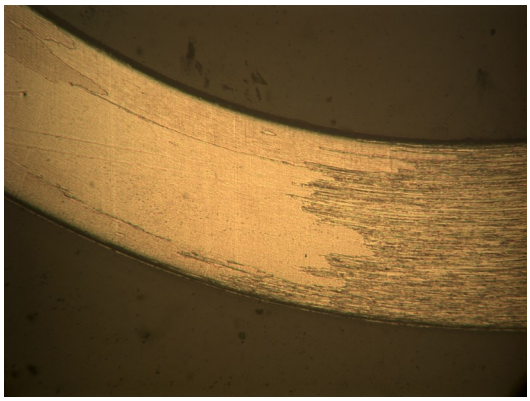


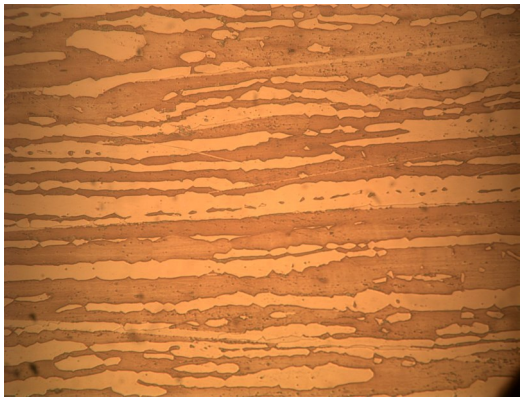
Example of induction hardened gear showing only hardening of the teeth 8x



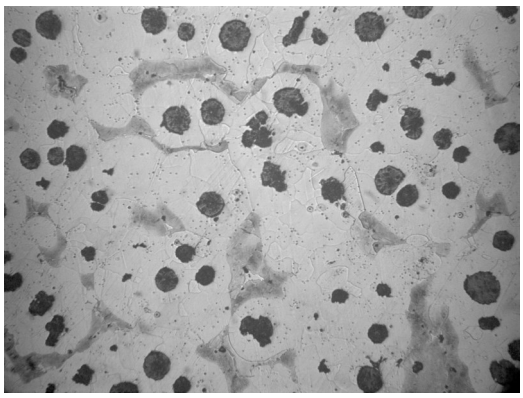
Example of Inconel sample etched to show grain size 400x



Example of etched sample showing partial annealing with coarse grains on the left and the original cold worked structure on the right 100x



A duplex stainless steel etched to show the two phases present 400x



To the left is an example of a ductile cast iron etched to show the relative amounts of ferrite (white) and pearlite (gray) 100x

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