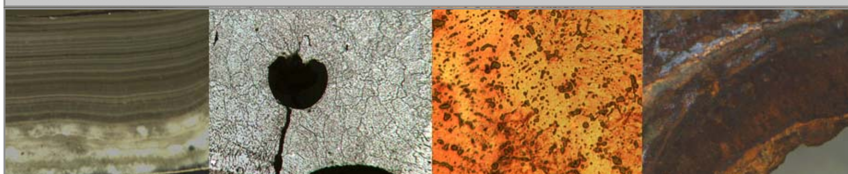
NUTS & BOLTS



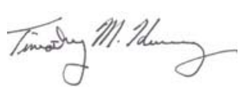
Effects of Alloying Elements

FEBRUARY 2011 / ISSUE 6

Welcome to New Hampshire Materials Laboratory

New Hampshire Materials Laboratory receives numerous calls a year requesting to have the alloying elements in steel verified. As many of you know, a substitution of an alloy element can change the composition of the alloyed steel causing unforeseen problems.

In this Nuts & Bolts issue, a table of alloying elements, their principle functions, and carbide tendencies are reviewed. If you work with any of these materials and have questions or problems that have occurred, please feel free to call our laboratory. Our knowledgeable staff members are here to assist you.



Tim Kenney
Laboratory Director

In This Issue

Quick Links

Services

Capabilities

Resources

Be sure to review our **industry definitions** if you need assistance with terminology

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Effects of Alloying Elements

Alloying Elements:	Carbide Forming Tendency:
Aluminum	less than iron, promotes graphitization
Principle Functions:	
With nitrogen or oxygen, aluminum forms a fine dispersion that limits grain growth	
A deoxidizer that results in excellent toughness because of the resulting fine grain size	
Forms a surface hardened layer by (relatively) low temperature diffusion of nitrogen (nitriding)	
Alloying Elements:	**Carbide Forming Tendency:**
Boron	moderate
Principle Functions:	
Significantly increases harden ability in the 0.0005 to 0.003% range, without sacrificing ductility or machinability	

NHML Staff Bio

Cullen Kulaga

Without our support staff, New Hampshire Materials Lab would not be able to run smoothly. Cullen has been our chemistry lab tech since 1998. (Cont. on next page)

Alloying Elements:	Carbide Forming Tendency:
Calcium	none
Principle Functions:	
When used as deoxidizer it provides better machinability than aluminum or silicon	
Controls inclusion shape in HSLA steels, improving toughness.	
Alloying Elements:	**Carbide Forming Tendency:**
Carbon	none
Principle Functions:	
The most important alloying element in steel as it forms pearlite, bainite, spherodite, and iron-carbon martensite	
Increasing carbon increases hardness, strength and ductile-brittle transition temperature	
Increasing carbon decreases toughness and ductility	
Alloying Elements:	**Carbide Forming Tendency:**
Chromium	greater than manganese and less than tungsten
Principle Functions:	
Provides a moderate contribution to hardenability up to about 1%	
Mildly resists softening during tempering	
Provides elevated temperature strength and resistance to oxidation	
With high carbon, provides abrasion resistance	
Alloying Elements:	**Carbide Forming Tendency:**
Cobalt	about the same as iron
Principle Functions:	
Resist softening at elevated temperatures	

Note that while no alloying additions result in sudden increases, or decreases in mechanical properties, corrosion resistance may be significantly altered by small changes in composition. For more alloying elements, their carbide forming tendency, and principle functions click here **Effects of Alloy Elements Continued.**

He does ICP analysis, the carbon and sulfur analysis, and assists with our new GDS machine.

Outside of work, Cullen can be found on the Rugby field.

Hardenability Calculation

A number of elements have been noted as having the ability to increase hardenability. Burns, Moore, and Archer (ASM Trans. 1938) developed a chemical factor calculation to quantify the effect of alloying additions. The chemical factor, as computed below has a direct relationship with Rockwell-inch hardenability.

Chemical factor = 1000 (% C) + 500 (% Mn) + 400 (% CR) + 100 (% Ni) + 25 (% Cu) + 1000 (% Mo)

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