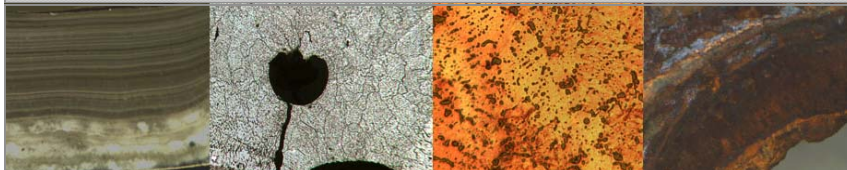


NU S & B L S



BASICS OF STEEL AND CAST IRON

APRIL 2012 / SUPPLEMENT

Welcome to New Hampshire Materials Laboratory

Think of all the things we use each day which are made of steel. Though some alloys include significant amounts of many elements to create just the right mixture of properties, many are “plain steel” with few alloying elements in the iron beyond carbon.

In designing and building even the simplest steel items, though, a specified chemical makeup was required, and possibly other mechanical specifications either as part of the raw material acceptance or final part of the QC process.

NHML is equipped to assess not just chemical composition of any alloy, but also hardness, tensile and yield strengths, elongation, and other mechanical properties.

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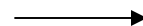
Industry Definitions

Austenite: a non-magnetic solid solution of carbon in face centered cubic (Gamma Iron). With appropriate alloying the phase can be stable at room temperature such as in 300 series of stainless steels

Bainite: is one of the decomposition products that can occur when austenite is cooled past a critical temperature of 727°C. It is a fine dispersion of carbide in ferrite upper Bainite forms below 450° to 500° C, lower Bainite below 350°C

Cementite: is a chemical compound of iron and carbon with a formula of Fe_3C . This iron compound is hard and brittle because it contains about seven percent carbon

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Basics of Steel and Cast Iron

Written by Wade Bartlett

It is easy to forget how much change results from a little carbon in iron, so let's review some basics of steel and cast iron. The **equilibrium phase diagram** is shown in the **figure 1 below**. The eutectic point of primary interest is indicated by a circle at 727°C and 0.68% carbon. (Article continued on page 2)

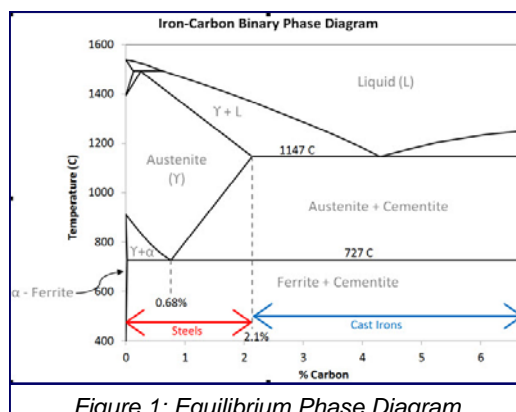


Figure 1: Equilibrium Phase Diagram

Carbon content of 0.05% to 0.15% is considered "low carbon", with mild steel up to 0.29%. These two are cheap, malleable and eminently weldable. They take surface treatments well (such as carburizing), but do not respond to heat-treating. They are commonly used for tasks requiring heavy sections. Steels with 0.3% to 1.7% carbon can be heat-treated to attain a specific microstructural composition, which can be crucial if very specific mechanical properties are required.

One combination of ferrite and cementite is called pearlite. In general, more rapid cooling procedures finger grained pearlite, while more gradual cooling creates coarser pearlite. Hypoeutectoid steels (less than 0.68 weight percent carbon) form a pearlitic structure with α -ferrite at the grain boundaries when cooled. Hypereutectoid steels (>0.68 wt% C) form full pearlite with small cementite grains scattered throughout. Though a eutectic or hypoeutectic steels can theoretically be transformed on cooling into pure pearlite, there is more commonly a portion of "retained austenite".

Many readers will recognize the term "martensite," but since it is not an equilibrium phase, it does not appear on the equilibrium diagram shown on the previous page. Martensite is formed when steels are cooled so rapidly from an austenite phase that the diffusion process necessary for equilibrium can not occur, but that is a discussion for another day.

Industry Definitions Continued:

Ferrite: A solid solution of carbon in body-centered cubic (Alpha) iron. It is stable at room temperature.

Martensite: A generic term for microstructure formed by diffusionless phase transformation. In steel it is a body centered tetragonal structure with carbon atoms in the interstitial positions of the matrix. The structure is highly strained and is accordingly hard and brittle.

Pearlite: A mixture of Ferrite and Cementite forming distinct layers or bands in slowly cooled carbon steels. The term Pearlite refers to its appearance under a microscope. The "mother of pearl" appearance is created by lamellar bands.

Interesting Steel Facts

- Steel is the most recycled material in North America-close to 69% of steel is recycled annually, more than plastic, paper, aluminum, and glass combined.
- Steel was first used for skyscrapers in the year 1883.
- It takes more than the wood of 40 trees to make a wood framed home-a steel framed homes uses 8 recycled cars.
- The first steel automobile was made in the year 1918
- 600 steel or tin cans are recycled every second.
- 83,000 tons of steel were used to make the Golden Gate Bridge.



[To read full article on Steel Properties and Interesting facts click here](#)