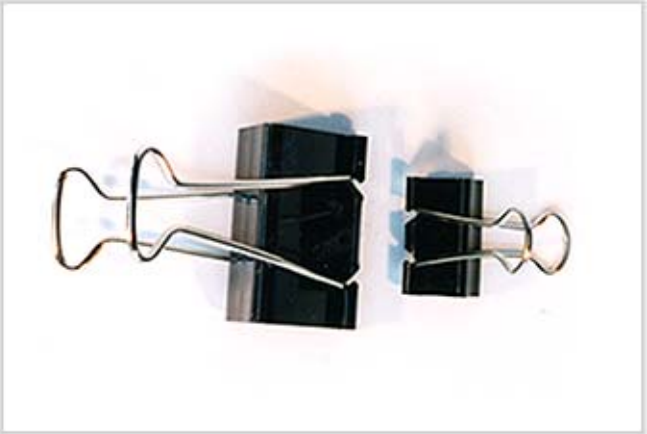
High carbon steel

Description

Image



Caption

1. Bearing made of high carbon steel. © Granta Design 2. Drawing board clips made of high carbon steel. © Granta Design

The material

High carbon steels (0.5-1.7% carbon) harden when quenched - a quality that gives great control over properties. High carbon steels achieve hardness sufficient for them to be used as cutting tools, chisels and cables, and "piano wire" - the metal strings of pianos and violins.

Composition (summary)

Fe/0.7 - 1.7%C

General properties

Density		487	-	493	lb/ft^3
Price	*	0.236	-	0.263	USD/lb
Date first used		1610			

Mechanical properties

Young's modulus		29	-	31.2	10^6 psi
Shear modulus		11.2	-	12.2	10^6 psi
Bulk modulus		22.5	-	25.4	10^6 psi
Poisson's ratio		0.285	-	0.295	
Yield strength (elastic limit)		58	-	168	ksi
Tensile strength		79.8	-	238	ksi
Compressive strength		48.6	-	168	ksi
Elongation		7	-	30	% strain
Hardness - Vickers		160	-	650	HV
Fatigue strength at 10^7 cycles	*	40.8	-	87.9	ksi
Fracture toughness		24.6	-	83.7	ksi.in^0.5
Mechanical loss coefficient (tan delta)	*	3e-4	-	9.8e-4	

Thermal properties

Melting point		2.35e3	-	2.69e3	°F
Maximum service temperature	*	662	-	752	°F
Minimum service temperature	*	-99.7	-	-27.7	°F
Thermal conductor or insulator?		Good conductor			
Thermal conductivity		27.2	-	30.6	BTU.ft/h.ft^2.F
Specific heat capacity		0.105	-	0.122	BTU/lb.°F

Thermal expansion coefficient	6.11	-	7.5	µstrain/°F

Electrical properties

Electrical conductor or insulator?	Good conductor			
Electrical resistivity	17	-	20	µohm.cm

Optical properties

Transparency	Opaque			

Processability

Castability	2	-	3	
Formability	4	-	5	
Machinability	3	-	4	
Weldability	5			
Solder/brazability	5			

Eco properties

Embodied energy, primary production	* 2.74e3	-	3.03e3	kcal/lb
CO2 footprint, primary production	* 1.71	-	1.89	lb/lb
Recycle	✓			

Supporting information

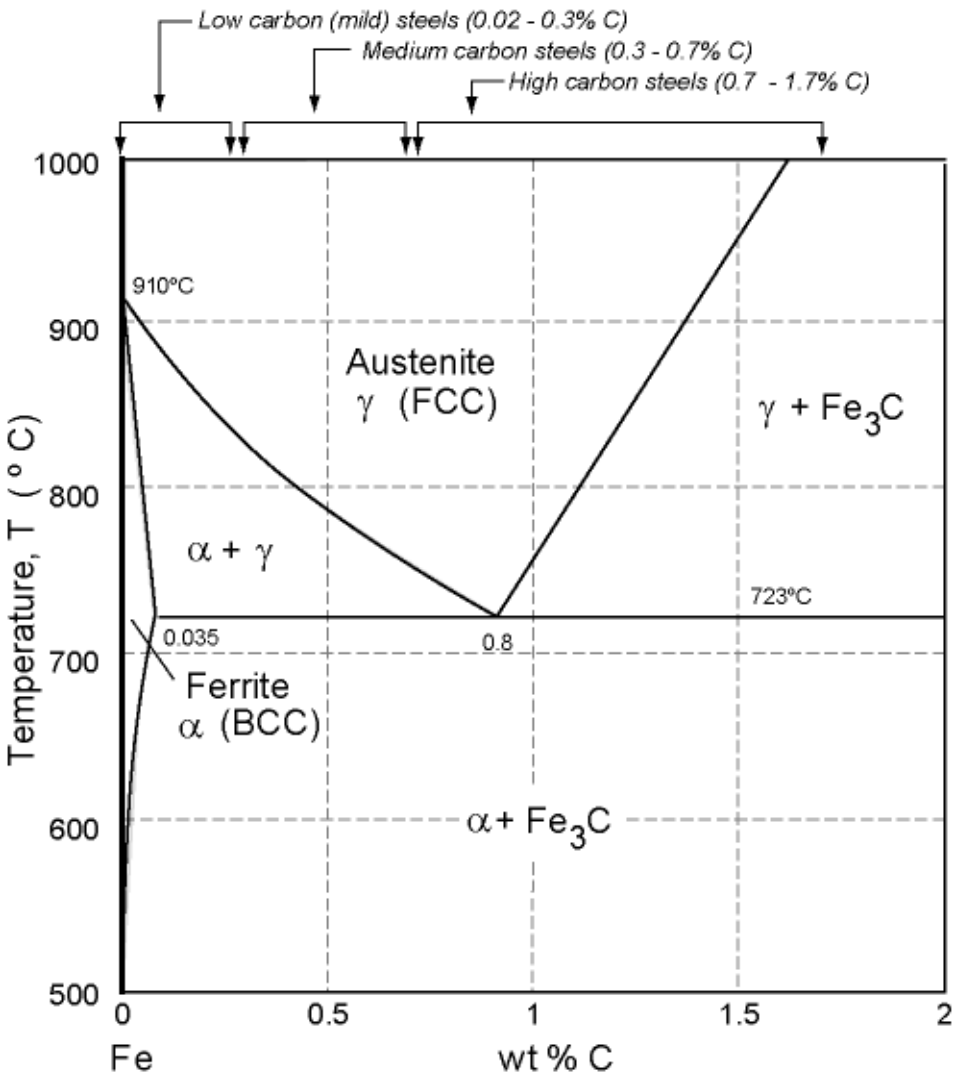
Design guidelines

Hardenability measures the degree to which it can be hardened in thick sections; plain carbon steels have poor hardenability - additional alloying elements are used to increase it (see Low alloy steels).

Technical notes

The two standard classifications for steels, the AISI and the SAE standards, have now been merged. In the SAE-AISI system, each steel has a four-digit code. The first two digits indicate the major alloying elements. The second two give the amount of carbon, in hundredths of a percent. Thus the plain carbon steels have designations starting 10xx, 11xx, 12xx or 14xxx, depending on how much manganese, sulfur and phosphorus they contain. The common low-carbon steels have the designations 1015,1020, 1022, 1117,1118; the common medium carbon steels are 1030,1040, 1050, 1060, 1137, 1141, 1144 and 1340; the common high alloy steels are 1080and 1095. More information on designations and equivalent grades can be found on the Granta Design website at www.grantadesign.com/designations

Phase diagram



Phase diagram description

High carbon steels are alloys of iron (Fe) with 0.7 - 1.7% carbon (C), for which this is the phase diagram.

Typical uses

Cutting tools; high performance bearings, cranks and shafts, springs, knives and scissors, rail track.

Links

Reference

ProcessUniverse

Producers