Technical Datasheet

CarTech® Ferrium® C61™ Alloy

Identification

U.S. Patent Number

- 6,176,946 B1
- 6,464,801
- 6,485,582
- 6,635,126

UNS Number

- K93061

Type Analysis

Single figures are nominal except where noted.

Carbon	0.15 %	**Chromium**	3.50 %
Nickel	9.50 %	**Molybdenum**	1.10 %
Cobalt	18.00 %	**Vanadium**	0.08 %
Iron	Balance		

General Information

Description

A premium quality carburizing steel that offers high core strength, high fatigue strength, high temperature resistance and high hardenability versus AISI 9310, X53 (AMS 6308), EN36 and other standard carburizable alloys. Benefits of using Ferrium C61 include light weighting of components and increasing power density.

Applications

Typical applications include power transmission shafts, gears and other demanding applications in aerospace, energy, and racing/off-road/mission-critical vehicles and other industries where weight savings, compactness, high temperature resistance and high surface fatigue resistance are valued.

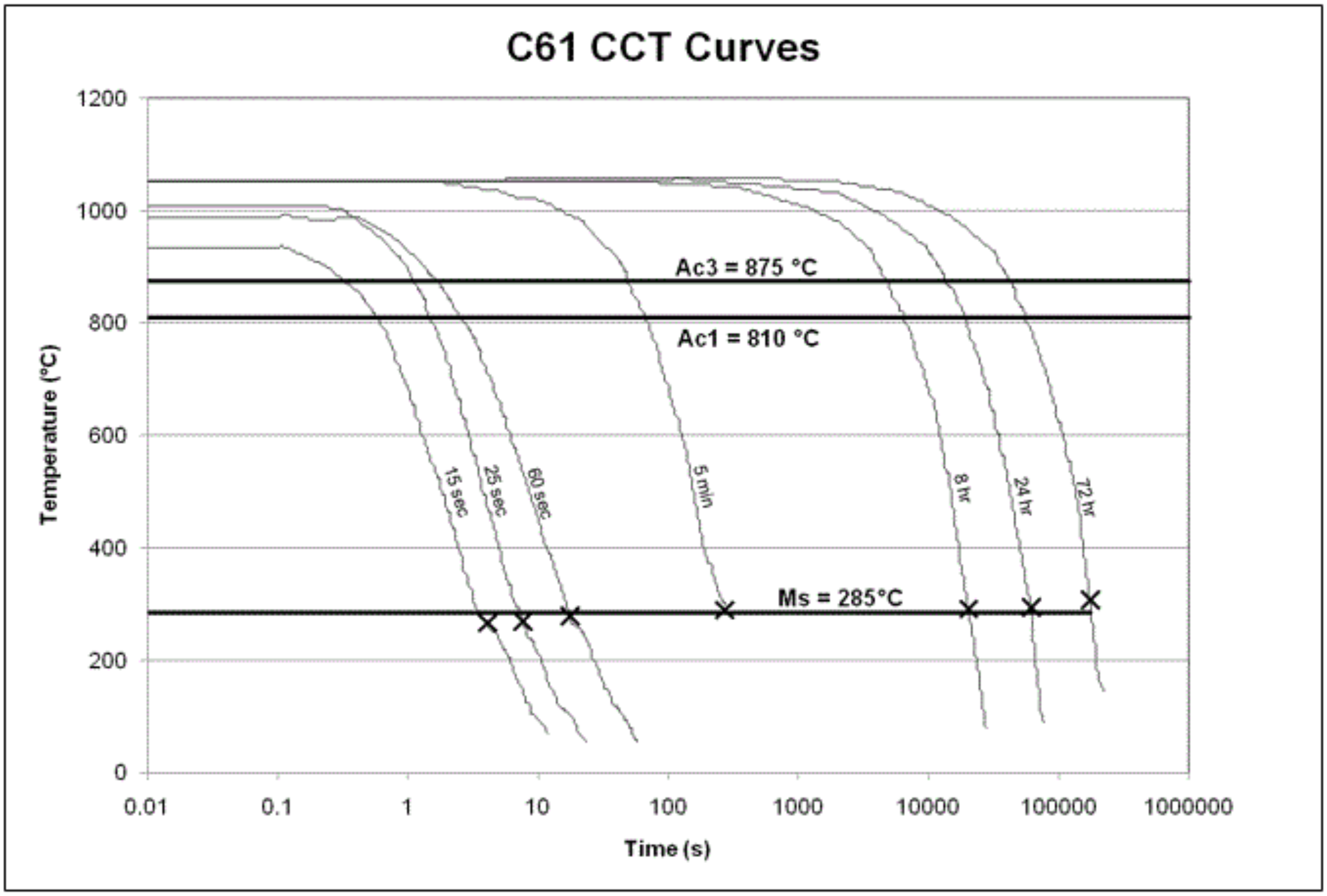
Elevated Temperature Use

See Properties for Elevated Temperature Tensile Performance.

Properties

Physical Properties

Density	0.2880	lb/in³
Mean CTE		
75 to 200°F	5.30	x 10^{-6} in/in/°F
75 to 400°F	5.33	x 10^{-6} in/in/°F
75 to 600°F	5.98	x 10^{-6} in/in/°F
75 to 800°F	6.16	x 10^{-6} in/in/°F
75 to 1000°F	6.27	x 10^{-6} in/in/°F
Critical Temperature (AC1)	1490	°F
Critical Temperature (AC3)	1610	°F
Martensite Start	550	°F



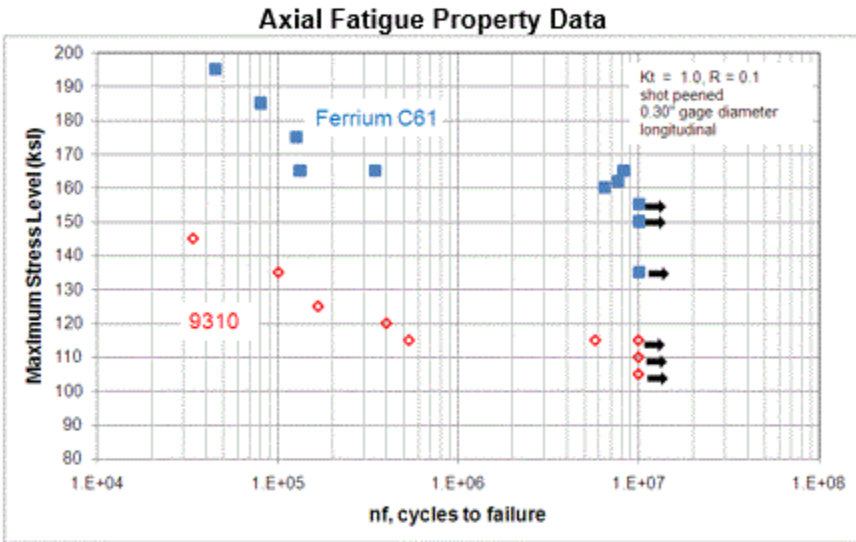
Continuous cooling transformation (CCT) curve of *Ferrium* C61.
Ferrium C61 is manufactured and sold under license from QuesTek Innovations LLC.
Data provided courtesy of QuesTek Innovations LLC.

Typical Mechanical Properties

Average Jominy End Quench Hardenability

	Distance from Quenched End (1/4 inch)							
	1	2	3	4	5	6	7	8
Rockwell C	45	45	44.5	44	44	44	44	44

Ferrium C61 is a secondary hardening steel that will increase hardness after tempering. (Typical core hardness after tempering is 47 – 50 HRC)



Axial Fatigue of *Ferrium* C61 compared to 9310
Ferrium C61 is manufactured and sold under license from QuesTek Innovations LLC.
Data provided courtesy of QuesTek Innovations LLC.

Typical Mechanical Properties									
Core Tensile Properties of *Ferrium C61*									
Test Temperature		Tensile Strength		Yield Strength		Elongation	R. of A.	Fracture Toughness	
°F	°C	ksi	MPa	ksi	MPa	(% in 1")	(%)	ksi√in	MPa√m
Room Temperature		240	1655	225	1551	15	68	130	143
400	204	220	1517	200	1379	15	68	-	-
600	316	220	1517	195	1344	15	68	-	-
800	427	200	1379	175	1207	15	68	-	-

Heat Treatment

Normalizing

Heat uniformly to 1800°F (982°C) and air cool.

Annealing

Heat uniformly to 1250°F (677°C), hold for 2 to 8 hours and air cool.

Carburizing

Vacuum carburize at 1830°F (1000°C), followed by quenching in gas (1.5 Bar Nitrogen or higher) or oil medium.

Quenching

Gas, Oil, Salt.

Cold Treatment

A refrigeration treatment at -100°F (-73°C) or lower for 1 hour is recommended. This should be performed with minimal delay after completion of the quench.

Straightening

Operations such as shaft straightening (if required) should preferably be done after the sub zero treatment but prior to the temper. C64 achieves full mechanical strength after tempering, and thus trying to straighten parts after tempering will be more difficult.

If excessive distortion exists after the solution treatment, quench and sub-zero treatment, then it is recommended to heat the part to 392°F (200°C) in air for 1 hour, hot-straighten the part (temperature determined by amount of force required to straighten part; temperature should be maintained below 700F (371C) to avoid any tempering or decarburization; a small oxide layer may form at this temperature), and allow the component to air cool. The full temper cycle must then be applied.

Tempering

Temper at 900°F (482°C) for 16 hours and air cool. It is preferred that tempering be performed in vacuum but can also be performed in air.

Workability

Hot Working

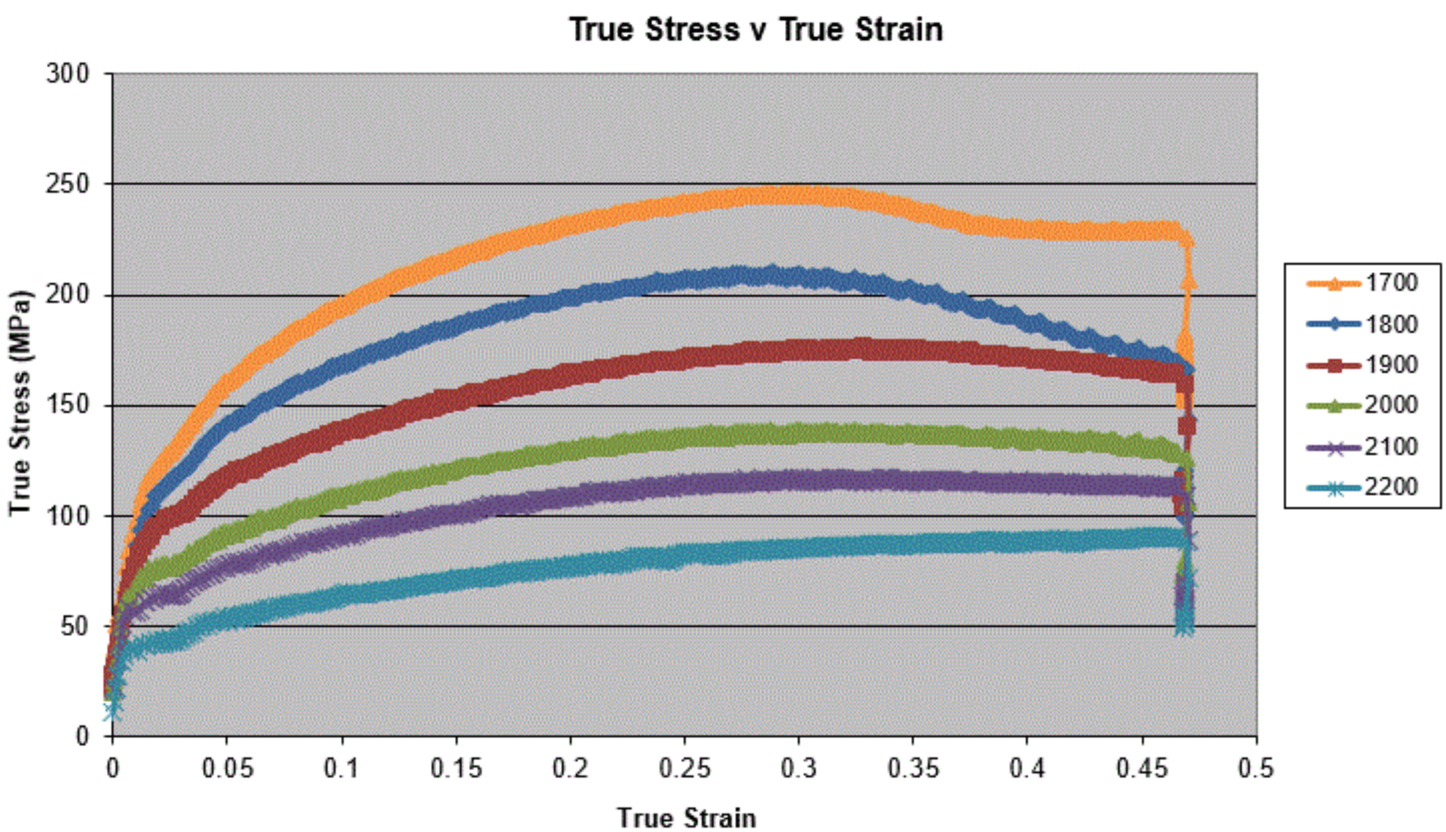
1800 – 2100°F (982 – 1149°C)

Recommended reduction ratio of 4:1.

Gleeble Testing for Flow Stress

*Gleeble is a registered trademark of Dynamic Systems Inc.

Strain rate at temperature = 1/sec



Forging

Standard forging of billet and bar stock should be conducted at 1800 – 2050°F (982 – 1121°C). If higher forging temperatures are preferred, hot fire temperatures of 2300-2350°F (1260 – 1288°C) may be used, provided a minimum of 4:1 forging reduction ratio is achieved. Following forging the parts should be air cooled to room temperature, followed by normalization, cold treatment and annealing to improve machinability.

Machinability

Bars and Forgings for machining shall not exceed 352 HRB, or equivalent, as descaled.

Preheating of Dies

None

Other Information

Descaling (Cleaning)

Bar Peeling

Metallurgical Requirements

Metallurgical Requirements

Per below material specifications.

Applicable Specifications

Note: While this material meets the following specifications, it may be capable of meeting or being manufactured to meet other general and customer-specific specifications.

- AMS 6517
- D210-13802-1

Forms Manufactured

- Bar-Flats
- Bar-Rectangles
- Bar-Rounds
- Billet

References

SAE AMS 2759/3 for thermal processing

SAE AMS 2759/9 for hydrogen bake out parameters

SAE AMS 2759/11 for stress relieve parameters

Edition Date: 10/26/2015