FERRIUM® C61

Applicable specifications: AMS 6517, D210-13802-1

Associated specifications: U.S. Patents 6,176,946 B1, 6,485,582, 6,464,801, and 6,635,126; UNS K93061

Type analysis

Single figures are nominal except where noted.

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

Forms manufactured

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

Description

Ferrium C61 is 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. The benefits of using Ferrium C61 include light weighting of components and increasing power density.

Key Properties:

- High core strength
- High surface fatigue resistance
- High hardenability
- High temperature resistance

Markets:

- Aerospace
- Automotive
- Energy

Applications:

- Gears
- Power transmission shafts

Ferrium C61 is manufactured and sold under license from QuesTek Innovations LLC.

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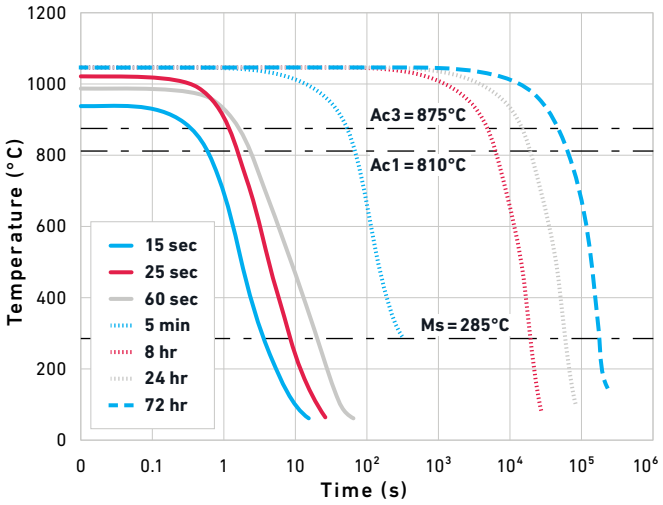
Physical properties

PROPERTY	At or From	English Units
DENSITY	—	0.2880 lb/in^3
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) CURVES



Data provided by Questek Innovations LLC.

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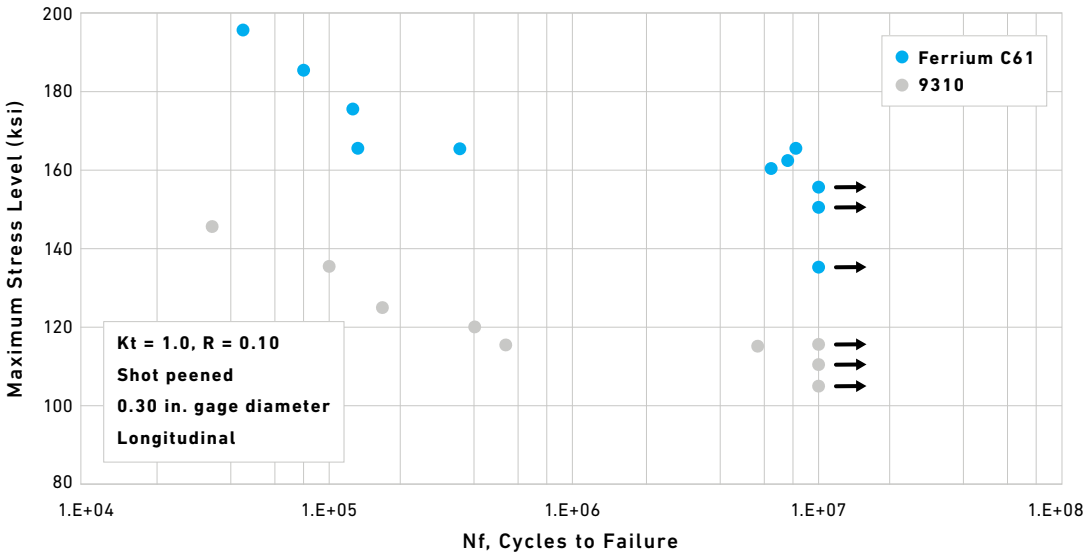
Typical mechanical properties

Ferrium C61 is a secondary hardening steel that will increase hardness after tempering. The typical hardness after tempering is 47–50 HRC.

AVERAGE JOMINY END QUENCH HARDENABILITY								
DISTANCE FROM QUENCHED END (1/4 INCH)	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Rockwell C	45.0	45.0	44.5	44.0	44.0	44.0	44.0	44.0

AXIAL FATIGUE VS 9310



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CORE TENSILE PROPERTIES

TEST TEMPERATURE		TENSILE STRENGTH		YIELD STRENGTH		ELONGATION	REDUCTION OF AREA	FRACTURE TOUGHNESS	
°F	°C	ksi	MPa	ksi	MPa	% IN 1 INCH	%	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.

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Straightening	Operations such as shaft straightening (if required) should preferably be done after the sub zero treatment but prior to the temper. Ferrium C61 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 700°F (371°C) 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	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.

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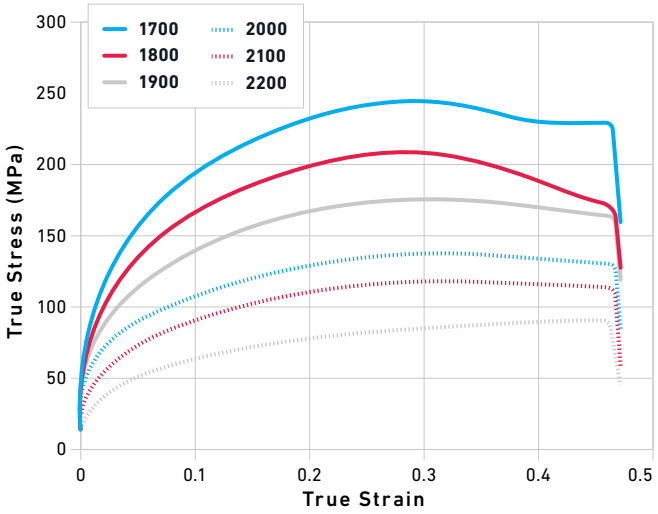
TRUE STRESS VS TRUE STRAIN



Other Information

Descaling (cleaning)	Bar peeling.

For additional information, please contact your nearest sales office:
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