

# PYROWEAR® 61

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.

<b>Iron</b>	Balance	<b>Cobalt</b>	18.00 %	<b>Nickel</b>	9.50 %
<b>Chromium</b>	3.50 %	<b>Molybdenum</b>	1.10 %	<b>Carbon</b>	0.15 %
<b>Vanadium</b>	0.08 %				

## Forms manufactured

Bar-Flats

Bar-Rectangles

Bar-Rounds

Billet

## Description

Pyrowear 61 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 Pyrowear 61 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:

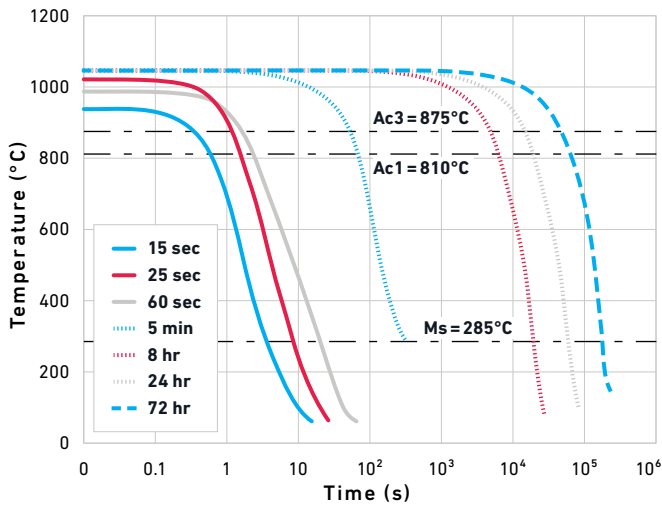
- Gears
- Power transmission shafts

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Physical properties

PROPERTY	At or From	English Units
DENSITY	—	0.2880 lb/in <sup>3</sup>
MEAN CTE	75 to 200°F	5.30 x 10 <sup>-6</sup> in/in/°F
	75 to 400°F	5.33 x 10 <sup>-6</sup> in/in/°F
	75 to 600°F	5.98 x 10 <sup>-6</sup> in/in/°F
	75 to 800°F	6.16 x 10 <sup>-6</sup> in/in/°F
	75 to 1000°F	6.27 x 10 <sup>-6</sup> 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.

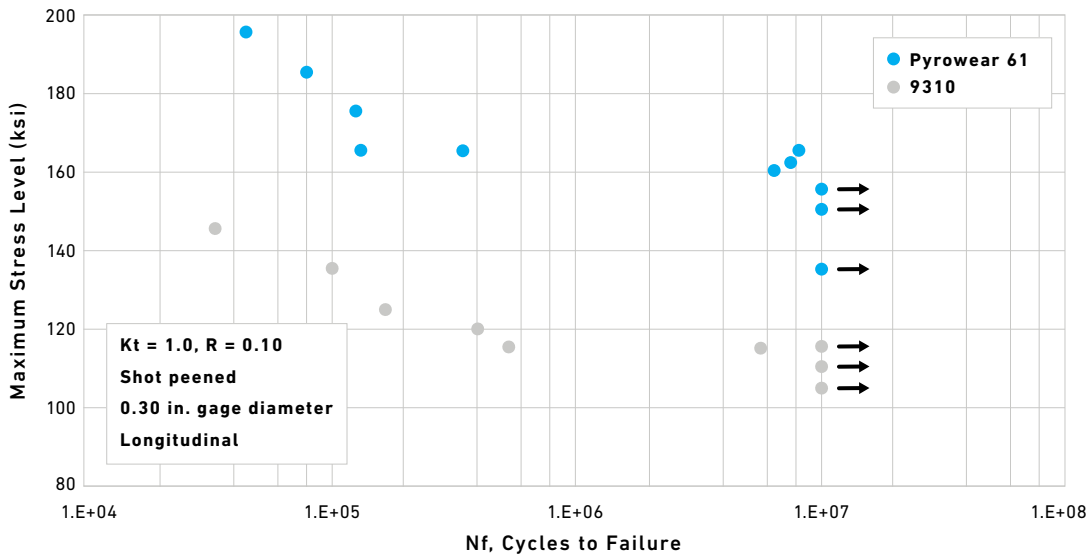
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Typical mechanical properties

Pyrowear 61 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

<b>Normalizing</b>	Heat uniformly to 1800°F (982°C) and air cool.
<b>Annealing</b>	Heat uniformly to 1250°F (677°C), hold for 2 to 8 hours, and air cool.
<b>Carburizing</b>	Vacuum carburize at 1830°F (1000°C), followed by quenching in gas (1.5 bar nitrogen or higher) or oil medium.
<b>Quenching</b>	Gas, oil, salt.
<b>Cold treatment</b>	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.

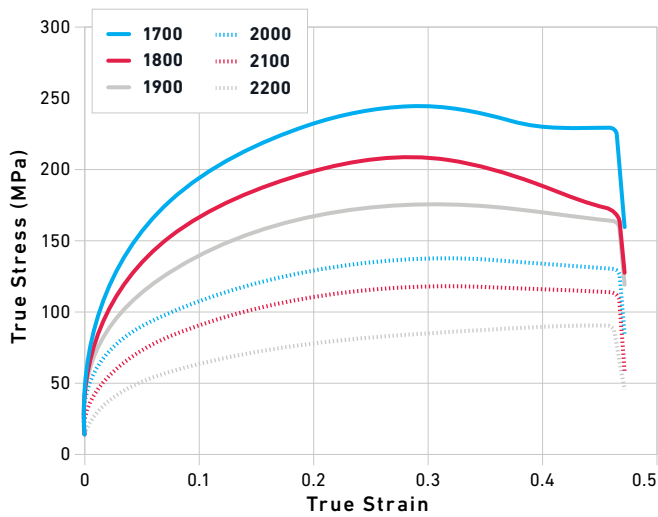
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<b>Straightening</b>	<p>Operations such as shaft straightening (if required) should preferably be done after the sub zero treatment but prior to the temper. Pyrowear 61 achieves full mechanical strength after tempering, and thus trying to straighten parts after tempering will be more difficult.</p> <p>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.</p>
<b>Tempering</b>	<p>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.</p>
<b>Workability</b>	
<b>Hot working</b>	<p>1800–2100°F (982–1149°C)</p> <p>Recommended reduction ratio of 4:1.</p>
<b>Gleeble* testing for flow stress</b>	<p>Strain rate at temperature = 1/sec.</p>
<b>Forging</b>	<p>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.</p>
<b>Machinability</b>	<p>Bars and forgings for machining shall not exceed 352 HRB, or equivalent, as descaled.</p>
<b>Preheating of dies</b>	<p>None.</p>

\*Gleeble is a registered trademark of Dynamic Systems Inc.

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**TRUE STRESS VS TRUE STRAIN**



**Other Information**

**Descaling (cleaning)**

Bar peeling.

**For additional information, please  
contact your nearest sales office:**

info@cartech.com | 610 208 2000

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