QUESTEK® INNOVATIONS LLC

FERRIUM® C61

Case-Hardened Gear Steel with Ultrahigh-Strength Core

Overview of Ferrium® C61 Properties

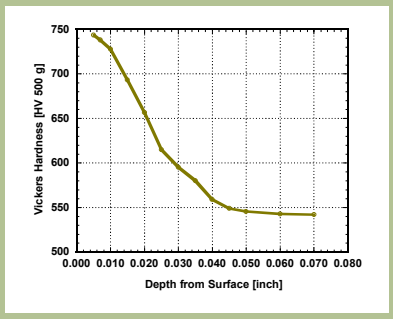
Temper	YS (ksi)	UTS (ksi)	El (%)	Core Hardness (HRC)	CVN (ft-lb)	K_{IC} $\left(ksi\sqrt{in}\right)$
Peak	*230*	*250*	*16*	*50-52*	*40*	*>105*
Overage	*225*	*240*	*16*	*48-50*	*50*	*>105*

Materials By Design® Objective

Advances in auto racing engine designs and increased engine power have caused an increase in the failure of dog rings, gears, camshafts, input shafts, racks and pinions. The design objective for *Ferrium*® C61 was to develop a high performance secondary-hardening gear and bearing steel with similar surface properties to conventional gear steels such as AISI 9310 and EN36C, but with the added benefits of a ultrahigh-strength core and excellent fracture toughness.

Description

Ferrium C61 is a member of a new class of martensitic secondary-hardening gear and bearing steels that utilize an efficient M_2C precipitate strengthening dispersion. Because of the efficiency of this strengthening dispersion, a superior combination of properties can be attained for a given application. *Ferrium* C61 was designed to provide carburized surface properties (60-62 HRC) similar to conventional gear steels such as AISI 9310 and EN36C with the added benefit of an ultrahigh-strength core along with excellent fracture toughness. A typical hardness profile of carburized *Ferrium* C61 is shown to the left.



Advantages

Ferrium C61 is targeted as a superior alternative to current gear materials in applications where component redesign is not feasible, but elevated core strength is required. *Ferrium* C61 has surface-wear properties, toughness, and fatigue properties similar to those found in current commercial alloys such as AISI 9310 and EN36C, but it also possesses an ultrahigh-strength core.

Processing

Ferrium C61 was designed for high-temperature carburizing. This allows solution heat treatment to be combined with the carburizing treatment and *Ferrium* C61 is therefore quenched directly from the carburizing temperature. After quenching to room temperature *Ferrium* C61 is subjected to liquid nitrogen immersion to assure a complete martensitic transformation. *Ferrium* C61 is typically tempered at 900°F (482°C) and has excellent thermal resistance approaching this temperature. If desired, *Ferrium* C61 can be nitrided to increase the surface hardness to near 70 HRC (1100 HV).

For additional information regarding QuesTek's Ferrium C61 contact ***Charles J. Kuehmann*** *by e-mail or call 847.425.8222.*

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Case carburizing produces a gradient in the volume fraction of the M_2C carbides and results in an increase in hardness and surface residual compressive stress. The efficiency of the M_2C strengthening response allows this class of steels to achieve very high surface hardness with very low carbon content. Thus, this class of steels has the ability to achieve very high surface hardness without the formation of detrimental primary carbides. Final shot peening is recommended for superior fatigue performance.

Fatigue

Ferrium C61 alloy has the longest fatigue life of several materials evaluated and shows 15% enhancement over EN36C in a notch bending fatigue test. The sample is a Ford Research Lab design, incorporating 4-point loading and an approximately 0.050 inch notch root radius. All samples were finish ground and shot peened after heat treatment.

Alloy	Cycles to Failure
Ferrium C61	*4.61×10^4*
EN36C	*4.00×10^4*

Product Forms

Ferrium C61 is manufactured in typical ingot, bar and billet forms.

Other

US Patent Number 6,176,946 B1.

Mean Coefficient of Thermal Expansion			
Temperature Range		Heat Treated Condition	
°C	°F	10^{-6}/°C	10^{-6}/°F
20-100	*68-212*	*9.54*	*5.30*
20-200	*68-392*	*9.59*	*5.33*
20-300	*68-572*	*10.76*	*5.98*
20-400	*68-752*	*11.09*	*6.16*
20-500	*68-932*	*11.28*	*6.27*

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