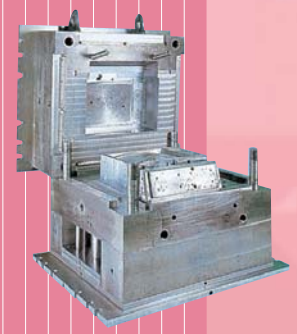
YSS
PLASTIC MOLD STEELS
CENA1



Innovated for 21century global standard grade.

- Solution for Mold Rust Problem
- 40HRC Prehardened Grade with Excellent Machinability
- Excellent Polishability, Crepability and EDMachinability
- Most Suitable for Weldless Molds

Features

CENA1, new concept tool steel for injection mold, breaks through with excellent machinability and rust resistivity. Manufactured by consumable electrode remelting process, CENA1 has low non-metallic inclusion content and excellent mirror polishability. CENA1 is delivered in 40HRC prehardened condition.

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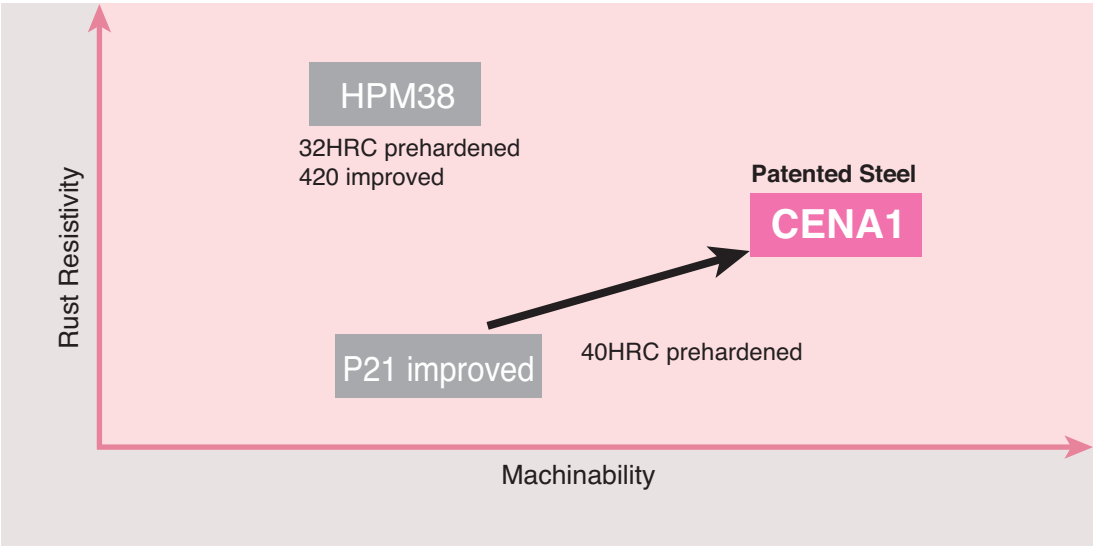
Characteristics



•Properties Comparison

excellent ◎>○>△>× poor

Grade	Hardness (HRC)	Machinability	Rust Resistivity	Mirror Polishability	Crepability	EDM Machinability
CENA1	**37-42**	◎	○	◎	◎	◎
P21 improved	37-41	○	×	◎	◎	◎
P21 improved and sulfulized	37-41	◎	×	○	△	△
P20 improved	29-33	◎	×	△	△	△
420 improved	29-33	△	◎	◎	◎	◎

Application and Actual Performance

●Application

●Molds for which temperature control is required (Weldless molds, etc.)
●Mold reguiring sensitive surface as mirror polishing, creping and EDM
OA equipment, Communication equipment
(ex.Mobile telephone, Video camera, CD case)
Home Electronics (ex.Cleaner, Air conditioner)
Auto parts (ex.Tail lamp, Inner panel,
Transparent cover)
Cosmetics case, bottle
●General resin

●Actual performance Example

Rust Resistivity

Application	Comparison of Actual Performance with Conventional Grade by Customers
Mobile Phone	Less rust and deformation during EDM. Less rust and corrosion by resins during molding. (Mold durability increase more than 4 times compared with conventional grade.)
CD Tray	Resistant to corrosive gas generated by ABS resin, mold maintainance frequency decreased drastically.
Electronics Parts	Least rusting during WEDM for 1 week. Rust removing process becomes unnecessary.
Mechanical Parts	Resistant to corrosive gas generated by advanced engineering resins. Mold durability is improved.

Machining

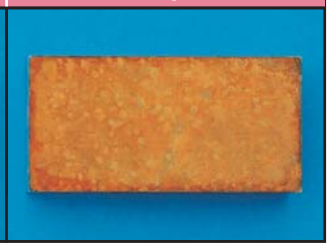
Air Conditioner Filter	**Less tool wear during precise rib machining and better surface obtained. Nitrided hardness 70HRC is effective to prevent mold depression by resin burr.**
Acrylic Lense	Carbide endmill tool life is doubled. Easy to mirror polish EDM surface.
TV Speaker	Many small pins ware EDMachined. Better EDM surface has been obtained compared with conventional grade.
Auto Head-light Lense	Good machinability in ball endmilling. Smooth surface machined with 0.4R ball endmill makes polishing easy.

Rust Resistivity

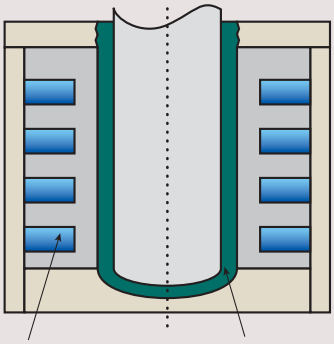
CENA1 has improved rust resistivity compared with conventional 40HRC prehardened grade.

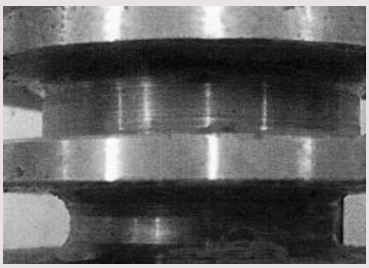
- Improvement of corrosion problem on mold surface by resins.
- Decreased rust formation at cooling water hole makes cooling effect stable.
- Fewer rust problem in storage, transportadion, or usage of mold
- Much less rust formation on WEDM surface

Rust Resistivity of Polished Surface

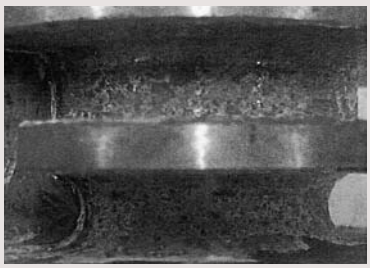
	CENA1	P21 improved
Dip in Water for 24Hrs		

Actual Performance Example of Rust Decreasing at Cooling Water Grooves of PET Parison Mold





CENA1 No plating



P21 improved and sulfurized+Cr plating

CENA1 Molding Result

	CENA1	P21 improved and sulfurized
Surface Treatment	No Plating	Cr Plating
Mold after 2 Months Use	Rust is removed easily by wiping.	Cr Plating came off and material was rusted deeply.

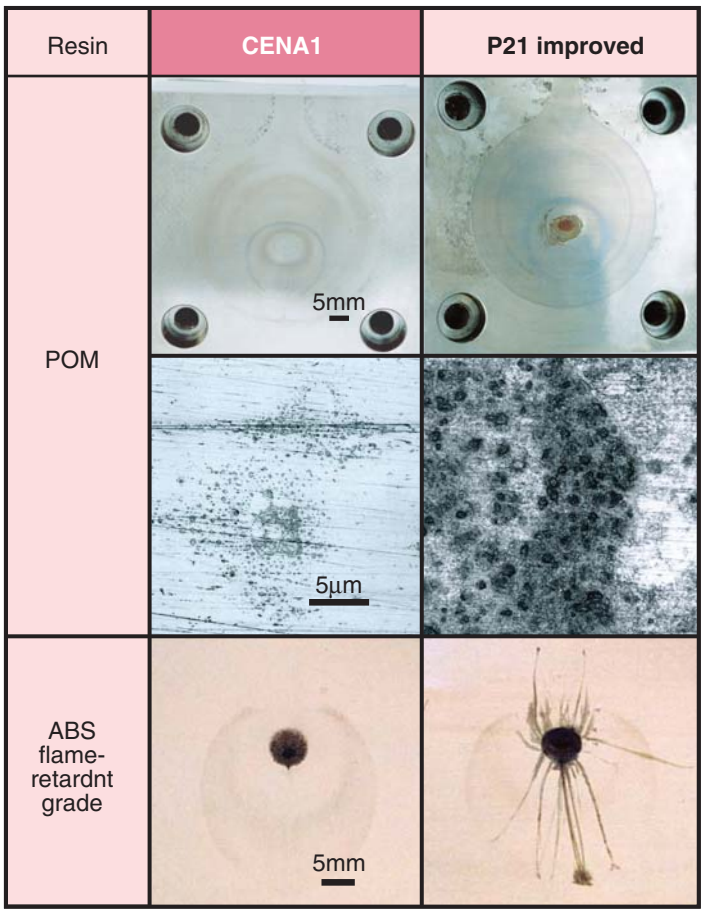
Photographs show water cooling grooves of the molds after 2 months use.
(3 cavities…CENA1, 3 cavities… P21 improved and sulfurized + Cr Plating, Total 6 cavities with one molding machine)

Rust Resistivity

CENA1 increases mold durability against corrosion by gas generated from resin.

Gas generated from resin often becomes high temperature by injection pressure and corrode the mold. It brings cloudiness of mirror surface and burr of injected parts.
CENA1 improves above gas-corrosion resistance by alloy combination.

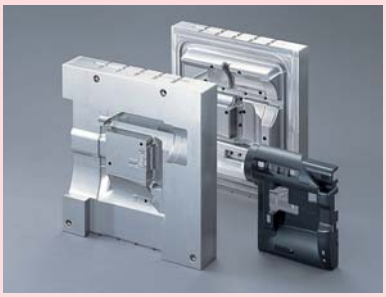
Figure
Acceleration gas-corrosion tests by a mold that is made to shut gas intentionally.
Observation results of the mold surface after 3000 shots of POM and ABS flame retardant grade.



Change on surface of specimens after injection molding tests

●CENA1 and Weldless Molds

CENA1 is most suitable for weldless molds for which temperature control is required, bucause surface condition of heating and cooling holes comes to be less corrosive and more stable.
CENA1 is widely used for the products such as PDP (Plasma display panel) and video cameras for better surface condition is indispensable.



Weldless Molds

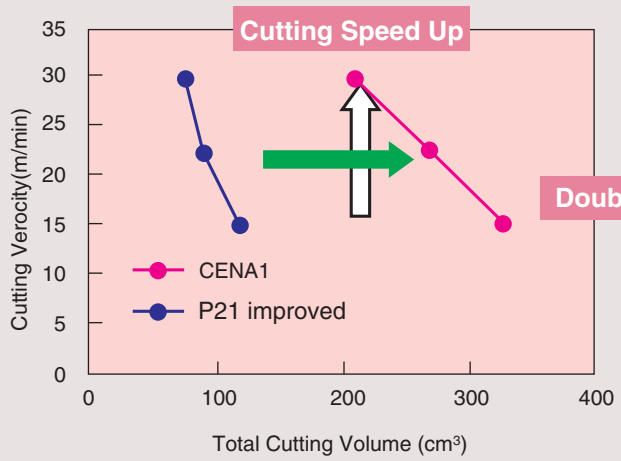
Machinability

Excellent machinability of CENA1 doubles tool life compared with conventional 40HRC grade tool steel in endmilling.

- **CENA1 can promote cutting efficiency**
- **CENA1 can decrease tool-change frequency drastically.**
- **Smooth cut surface of CENA1 makes afterpolishing easier.**

1.VT Curve

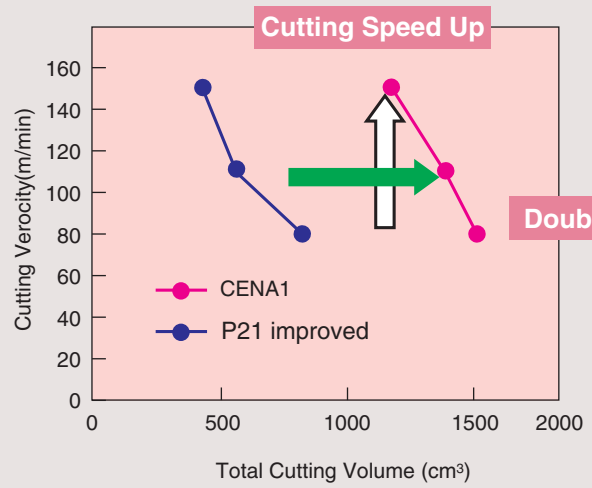
H.S.S.



HSS-Co 2NKR ø10 2teeth
Machine: Matsuura MC-800VF
Side Surface Cutting, Wet (Soluble),
Downcut,
Overhang: 35mm
Tool Life Definition: Tool Wear 0.3mm

Cutting Verocity (m/min)	Feed (mm/teeth)	Cutting Depth (mm)	Cutting Efficiency (cm³/min)
15	0.055	15Hx1W	0.80
22.5	0.055	15Hx1W	1.19
30	0.080	15Hx1W	2.30

Comented Carbide



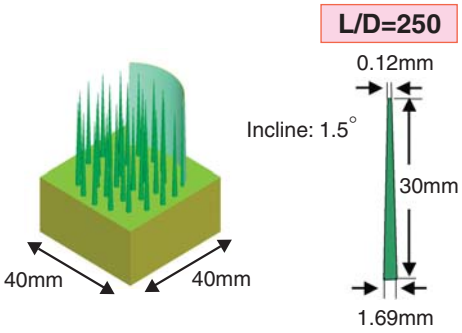
Carbide+Coating EPP4100 ø10 4teeth
Machine: Matsuura MC-800VF
Side Surface Cutting, Dry, Downcut,
Overhang: 35mm
Tool Life Definition: Tool Wear 0.15mm

Cutting Verocity (m/min)	Feed (mm/teeth)	Cutting Depth (mm)	Cutting Efficiency (cm³/min)
80	0.080	15Hx1W	6.11
113	0.080	15Hx1W	8.64
150	0.080	15Hx1W	11.47

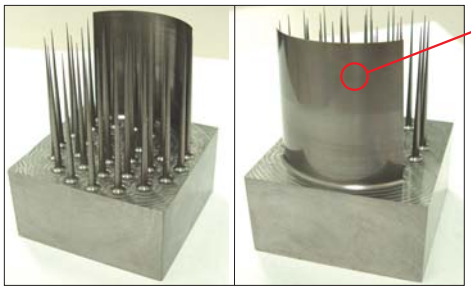
Machinability

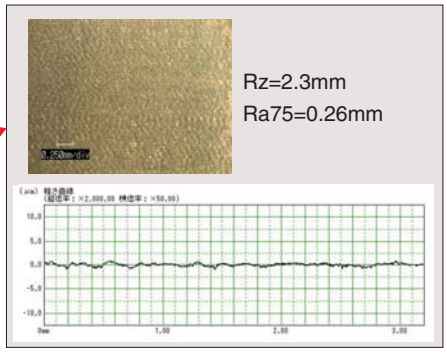
2.Endmilling Example

This sample was machined by one endmill for 22 hours.
Machined surface roughness is very smooth.



Tool : ø 3.0 2 teeth
EPDR2030-30-05-TH (Hitachi Tool)
Machine : MAKINO V33
Cutting Verocity: 50m/min (5300min^{-1})
Feed: 0.06mm/tooth (640mm/min)
Cutting Depth: 0.06mm
Pick Feed: 0.12mm
Dry (Air Blow)
Cutting time: 22Hr
Number of tool use: 1

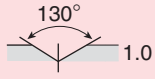




3.Drilling Condition

Deep hole machining condition

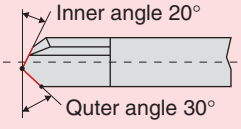
Dia.	Gread	Hole depth (mm)	Cutting Verocity (m/min)	Feed (mm/rev)	Step feed (mm)	Step back	Machined hole number	Remarks
ø0.6	SKH51(M2)	10(16D)	15	0.001	0.1		20	●Procedure
ø1	SKH51(M2)	10(10D)	20	0.003	0.2		60	1.Positioning (Starting drill)
ø1	Co-HSS+Coating	10(10D)	20	0.003	0.2		220	
ø1	Cemented Carbide +Coating	10(10D)	25	0.003	0.2		820	
ø2	SKH51(M2)	20(10D)	10	0.05	0.9		55	
ø3	SKH51(M2)	30(10D)	12	0.05	1.2		60	2.Machining drill
ø4	SKH51(M2)	40(10D)	12	0.05	1.3		83	
ø5	SKH51(M2)	50(10D)	12	0.06	1.5		105	
ø7	SKH51(M2)	42(6D)	15	0.1	2		200	
ø10	SKH51(M2)	90(9D)	13	0.13	2		50	



Machine : Vertical Machining Center Solution : Emulsion

Deep hole machining condition example by Gun drill

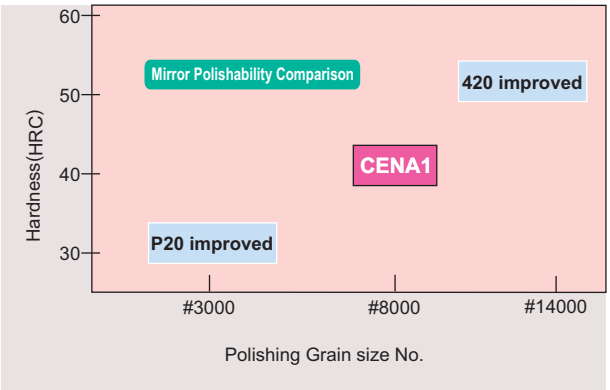
Dia.	Hole depth (mm)	Cutting verocity (m/min)	Feed (mm/rev)	Ejection pressure of cutting fluid (MPa)	Machined hole number	Remarks
ø3	80	25	0.007	4.9	6	
ø5	150	19	0.005	4.9	6	
ø11.5	500	48	0.012	3.6	8	
ø18	600	35	0.014	3.4	7	
ø25	700	47	0.02	2.9	6	
ø30	800	55	0.03	2.9	3	



Machine : Vertical Gundrill Solution : Oil

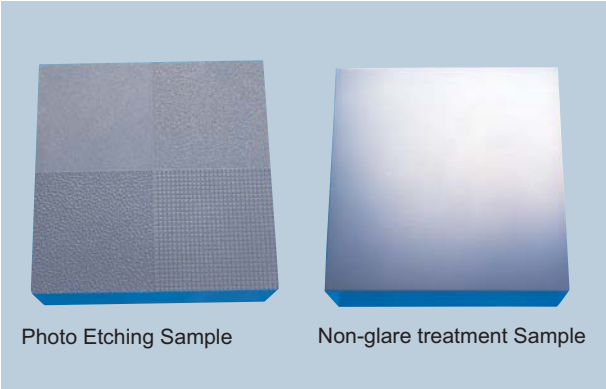
Mirror Polishability

CENA1 has very low non-metallic inclusion content and excellent mirror polishability.



Crepability

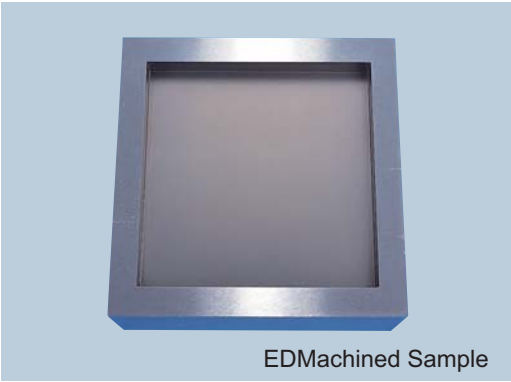
CENA1 has homogenized micro structure and good crepability.
CENA1 is suitable for precise creping.



・EDM surface Etching ・・・ Sand blasting treatment is needed before etching.
・Welded Surface Etching ・・・ Post-heating (≤ 200°C) after welding is needed before etching.

ED Machinability

CENA1 has good EDMachinability. As surface hardened layer is much less than conventional grades, CENA1 is able to be polished easier after EDMachining.



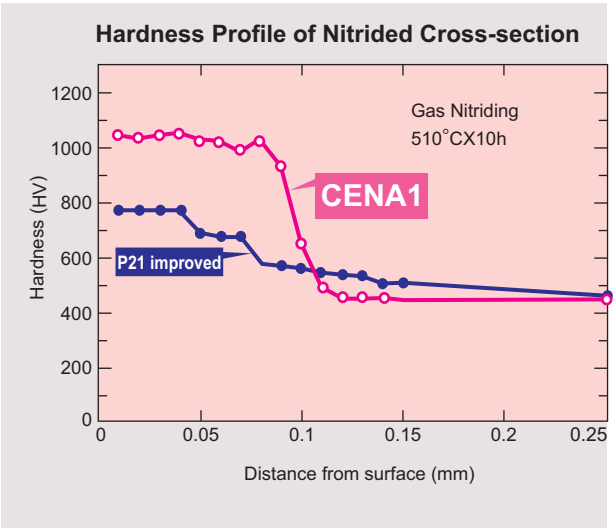
CENA1 100x100x50(mm)

(Condition)

Machine: HQSF(MAKINO), EDGE2S #108
Solution: Paraol 250
Additive: μSC (0.8-1.0g/L)
Electrode: Gr 78.0mm (EDM depth 1.0mm)
Cu 79.2mm (EDM depth 0.4mm)
Cu 79.7mm (EDM depth 0.15mm)

Nitriding Property

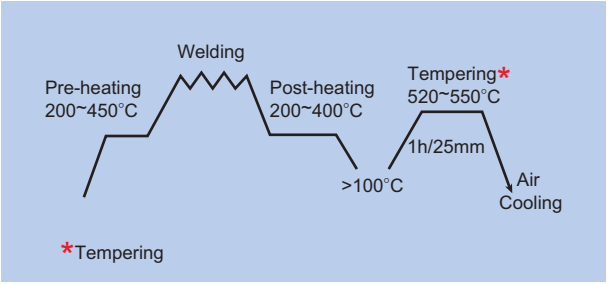
By nitriding, 1000HV surface hardness is obtained easily on CENA1, that is effective against wearing of slide core or mold for reinforced resin.



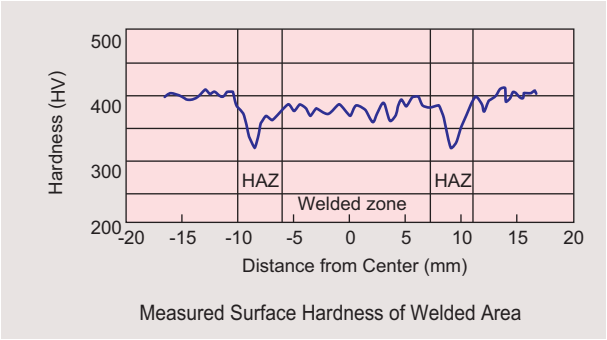
- The care is necessary to avoid breakage by over-hardening especially for small dia. pin or sharp edge part.
  It is recommended to apply lower nitriding temperature or soft nitriding condition.

Weldability

As welded area hardness variety of CENA1 is less than conventional grades, mold is able to be repaired and finished easily.

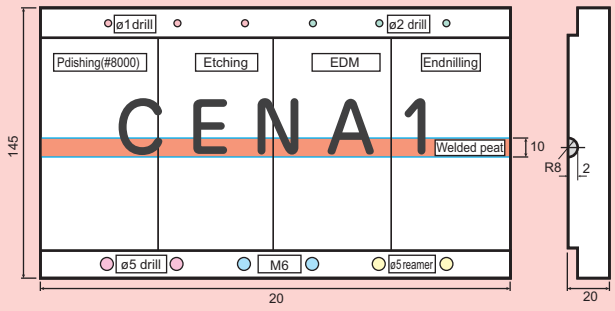


Welding repair is recommended to be done by TIG welding with CENA1-W rod.



Measured Surface Hardness of Welded Area

Welding Procedure Example

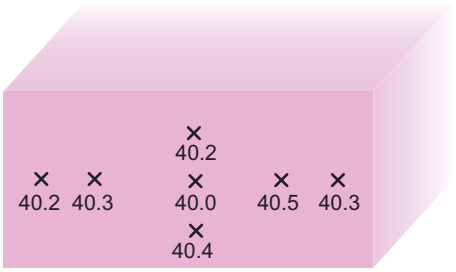


Photograph shows mirror polishing, creping, EDM and endmilling finished sample after welding repair (10mm width).
No weld mark is obserbed on each finished surface.

Hardness Distribution and Machanical Properties

Hardness Distribution

CENA1 shows almost uniform hardness distribution even in large cross-section material.



Measured hardness of flat bar
200^{t} X 510^{w} cross section.

Mechanical Properties

Representative value of flat bar 50tX400W.

Grade	Hardness (HRC)	Tensile Strength (N/mm^2)	Elongation (%)	Reduction of Area (%)	2U charpy impact value (J/cm^2)
CENA1	40	1,225	15	50	20

Physical Properties

Specific Grabity 7.78

Thermal Conductivity

W/(m·K)

Grade	20°C	100°C	200°C	300°C
CENA1	20.5	22.9	25.9	28.2

Thermal Expantion Coefficient

Average value from 30°C, $x10^{-6}$/°C

Grade	100°C	200°C	300°C	400°C
CENA1	10.8	11.5	12.0	12.4

Young's Modulus 205GPa

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