

# DAMASTEEL® DS96X™ STAINLESS GUN BARREL STEEL

## PRODUCT INFORMATION

Damasteel's stainless gun barrel steel is a RSP (Rapid Solidification Powder) based steel with AISI 416R/431 as the constituent alloys. The steel is a Damascus patterned steel developed and tested specifically for hunting firearm applications. This steel has gone through a torsion twisting operation to turn the grain structure towards the transverse direction. The results are improved ductility and fatigue properties compared to non-torsional variations of the steel. Damasteel's stainless gun barrel steel should be your first choice when it comes to:

- Producing a maintenance free product
- High hardness after hardening and tempering
- High corrosion resistance
- High ductility and fatigue properties
- High purity and cleanliness
- Ease of machining

Grade	Etch color	C	Si	Mn	Cr	Mo	P	S	Ni
416R	Dark	0,15	<0,5	<0,5	13	<0,6	<0,06	0,20	-
431	Bright	0,16	<1	<1	16	-	<0,04	<0,03	2

Table 1. Nominal chemical compositions in wt-% of the constituent alloys

## Mechanical and physical properties

Bar material delivered from Damasteel has the following approximate mechanical and physical values at 20°C.

Yield strength, Rp 0,2	380	MPa	Young's modulus	200	GPa
Tensile strength, Rm	<700	MPa	Poisson's ratio	0,3	-
Elongation, A5	22	%	Thermal conductivity	25	W/m·K
Hardness	<300	HV	Heat capacity	460	J/kg·K
Density	7,8	kg/dm <sup>3</sup>	Linear thermal expansion coefficient, α	10	μm/m·K

Table 2. Mechanical and physical properties of Damasteel DS96X™ in annealed condition.

## Corrosion resistance

Damasteel's stainless gun barrel steel has good corrosion resistance after hardening and tempering. 431 has excellent corrosion resistance and the grade 416R is a slightly modified version of the free-machining grade 416 which has a high resistance to acids, alkalis, fresh water and dry air.

## Heat treatment

Annealing at 660 °C (1220 F) for 5 hours.

Because of the risk of cracking; no grinding, cutting or machining should be done after hot working until the material is annealed. The recommendation is to have the material relaxation annealed which means five hours at 660 °C (1220 F). All material supplied from Damasteel is delivered in annealed condition.

Ac1 temperature 710 °C (1310 F)

Ac3 temperature 900 °C (1650 F)

For all heat treatment processes, a good control of the heating temperature is needed. An electric or gas fired furnace is recommended. Long heating times can lead to decarburization and scale formation.

## Hot working

Hot working temperature 900-1150 °C (1650-2100 F).

## Machining

Grade 416 steel is a free-machining stainless steel with a machinability of 85%, highest of all stainless steels. 416R is a slightly modified version of this alloy with still high machinability. 431 is easily machined in their annealed state. This steel is hard to machine if hardened above 400 HB.

Hardness		300 HB		400 HB	
Type		Speed m/min (ft/min)	Feed mm/rev (in/rev)	Speed m/min (ft/min)	Feed mm/rev (in/rev)
Drilling, HSS-drill 6 mm		10 (31)	0,08 (0,003)	7 (23)	0,08 (0,003)
Drilling, HSS-drill 18 mm		10 (31)	0,15 (0,006)	7 (23)	0,10 (0,004)
Gun drilling, carbide Ø 6 mm (1/4")		35 (115)	0,015 (0,0006)	30 (98)	0,013 (0,0005)
Ejection- or STS-drilling Ø 19 mm (3/4")		50 (164)	0,16 (0,006)	30 (98)	0,12 (0,005)
Reaming		Mm/tooth (in/tooth)		Mm/tooth (in/tooth)	
HSS		8 (26)	0,13 (0,005)	5 (16)	0,13 (0,005)
Carbide		18 (60)	0,20 (0,008)	12 (40)	0,20 (0,008)
Turning	Depth of cut	m/min (ft/min)	mm/rev (in/rev)	m/min (ft/min)	mm/rev (in/rev)
Coated carbide	1 mm (0,04 in)	150 (491)	0,30 (0,01)	90 (300)	0,13 (0,005)
	4 mm (0,16 in)	130 (426)	0,60 (0,025)	76 (250)	0,60 (0,025)
	8 mm (0,32 in)	90 (295)	0,50 (0,02)	60 (200)	0,50 (0,02)
Face milling	Depth of cut	m/min (ft/min)	mm/tooth (in/tooth)	m/min (ft/min)	mm/tooth (in/tooth)
Coated carbide	1 mm (0,04 in)	175 (573)	0,18 (0,007)	115 (375)	0,15 (0,006)
	4 mm (0,16 in)	120 (393)	0,15 (0,006)	90 (300)	0,10 (0,004)
	8 mm (0,32 in)	90 (295)	0,10 (0,004)	69 (225)	0,08 (0,003)
Grinding	Wheel identity	Wheel speed m/s (ft/min)	Work speed m/min (ft/min)	Infeed mm (in)	
Surface grinding	A46HV	30 (6000)	20 (70)	0,05 (0,002)	
Surface finishing	A46HV	30 (6000)	20 (70)	0,013 (0,0005)	
Cylindrical grinding	A46IV	30 (6000)	20 (70)	0,05 (0,002)	
Cylindrical finishing	A46IV	30 (6000)	20 (70)	0,013 (0,0005)	
Internal grinding	A46JV	30 (6000)	30 (105)	0,013 (0,0005)	
Internal finishing	A46JV	30 (6000)	30 (105)	0,005 (0,0002)	

Table 3. Machining data for DS96X™

## Welding

Welding of Damasteel's stainless gun barrel steel is a challenge due to the risk of cracking. It is recommended to pre-heat the materials to 200 – 300 °C (390 – 570 F) before welding, and carry out post-weld heat treatment at 650 °C (1200 F). Welding can be performed using grade 410 filler rods, but ductile welds can be achieved using grades 308L, 309 or 310.

## Hardening

Heat treatment of Ø 25 mm (1") bars for:

	Brinell Hardness (HB)	Approx. tensile strength (MPa)	Hardening	Tempering
I	300	1000 (66 tsi)	1040 °C / 1904 F	565 °C / 1050 F
II	400	1350 (87 tsi)	1040 °C / 1904 F	375 °C / 710 F

Table 3. Hardening and tempering suggestions for a Ø 25 mm bar with corresponding hardness

Harden the bar at 1040 °C (1900 F) for 30 min, quench in oil.

Tempering at 230 – 700 °C (440 – 1300 F) for 3 hours. Higher tempering temperature gives better fatigue and ductility properties but lower hardness and corrosion resistance.

## Surface treatment

When the piece is into shape, visible surfaces shall be carefully polished. Before etching, degrease and clean in acetone.

## Etching

To make the pattern in our steel visible, an etching has to be made. Depending on desired result, different acids and acids mixtures can be used. The surface finish is also influencing the result. In the below table below are a few suggestions.

	Acid	Chem. comp.	Blend (%)	Time (min)	Color RWL34™	Color PMC27™
I	Hydrochloric acid 37 %	HCl	100	2-5	Bright grey	Light grey
II	Sulfuric acid 30 %	H <sub>2</sub> SO <sub>4</sub>	100	5-10	Light grey	Grey
III*	Hydrochloric acid 37 % Vinegar / Ferro chloride 30 %	HCl Vinegar/FeCl <sub>3</sub>	100 50/50	5 5	Bright grey	Dark grey

Table 4. Etching suggestions with corresponding colors and relief of the different alloys

1. Grind the piece progressively up to desired grit, 600 or higher. Finish off with polishing if desired.
2. Clean and degrease the piece carefully.
3. Mix the etching acid in the recommended ratios and remember to always pour the acid into the water.
4. Immerse the piece in the mix and leave it in for the time you choose. Longer soaking time will give deeper etch.
5. Neutralize the piece by dipping it into water with bicarbonate.

Beware of noxious fumes. Acids must be handled with great care.

\* Method number III is a high-contrast etching which requires two steps. First, etch in HCl then neutralize then directly afterwards etch in the mix of Vinegar and FeCl<sub>3</sub>. A light buff at the end can help to make the tops bright.

# Products and dimensions

Damasteel has a standard product program that can be found on our website [www.damasteel.com](http://www.damasteel.com).

We supply stainless gun barrel steel in following formats

- Round bars, dimensions  $\varnothing$  11-61 mm

BESPOKE PRODUCTS CAN BE SUPPLIED WITHIN THE LIMITS SHOWN IN CHART.

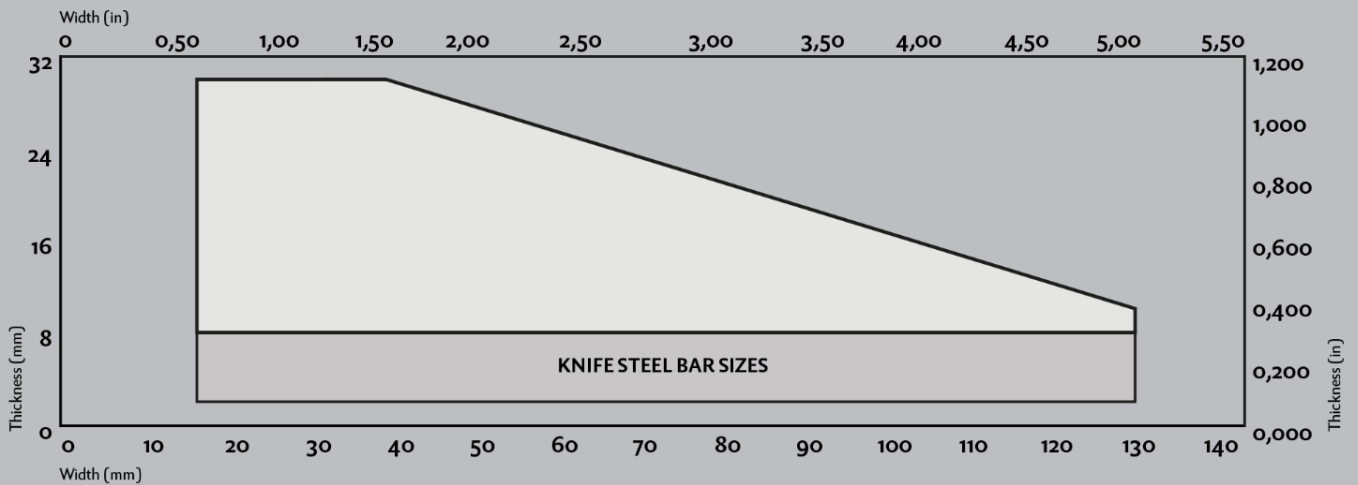


Figure 1: Size range

Even if it comes to creating customized patterns on our Damascus products or if you like dimensions outside our standard range either on our Damascus patterned steel grades (DS93X™, DS95X™, DS92X™, DS96X™) or our martensitic steels RWL34™ or Nitrobe77™ – do not hesitate to contact us.

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