

# DATA SHEET

## DSg6X™ 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 making a barrel of Damascus material. 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.

### Distinctive Feature

- High hardness after hardening and tempering
- High corrosion resistance
- High ductility and fatigue properties

### Mechanical and physical properties

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

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

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

Table 2. Mechanical and physical properties of Damasteel DSg6X™ in annealed condition.

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

### Hot working

Hot working temperature 1150-1220 °C (1650-2100 F). Do not forge below 900°C.

### 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. After welding we recommend a normalization, see heat treatment.

Welding can be performed using grade 410 filler rods, but ductile welds can be achieved using rods with grades 308L, 309 or 310.

## 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. Below in table 3 is some data for machining parameters.

Hardness		300 HB		400 HB	
Type		Speed m/min	Feed mm/rev	Speed m/min	Feed mm/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		35 (115)	0,015 (0,0006)	30 (98)	0,013 (0,0005)
Ejection, 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	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™

## Heat treatment

Annealing: 660 °C (1220 F) hold at temperature for 4 hours cool in air, achieved hardness around <25 HRC.

Normalization: 650 °C (1202 F) hold for 5 hours at temperature cool in air.

Because of the risk of cracking no grinding, cutting or machining should be done after hot working until the material is annealed.

For all heat treatment processes, a good control of the heating temperature is needed. Long heating times can lead to decarburization and scale formation.

## Hardening

Hardening temperature range: 950 °C-1010 °C, holding time at temperature 30 min.

Quenching: Oil or water

Tempering: Temperature from 230 °C to 700 °C (440 – 1300 F), holding time 3 hours at tempering temperature.

Higher tempering temperature gives better fatigue and ductility properties but lower hardness and corrosion resistance. In table 3 there are some Hardening suggestions and corresponding hardness and yield strength. Diagram 1 showing hardness and yield strength depending on tempering temperature.

	Hardening	Tempering	Estm Tensile strength (MPa)	Brinell Hardness (HB/HRC)
I	1040 °C / 1904 F	565 °C / 1050 F	1000 (66 tsi)	300/ 34,3
II	1040 °C / 1904 F	375 °C / 710 F	1350 (87 tsi)	400/ 48,0

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

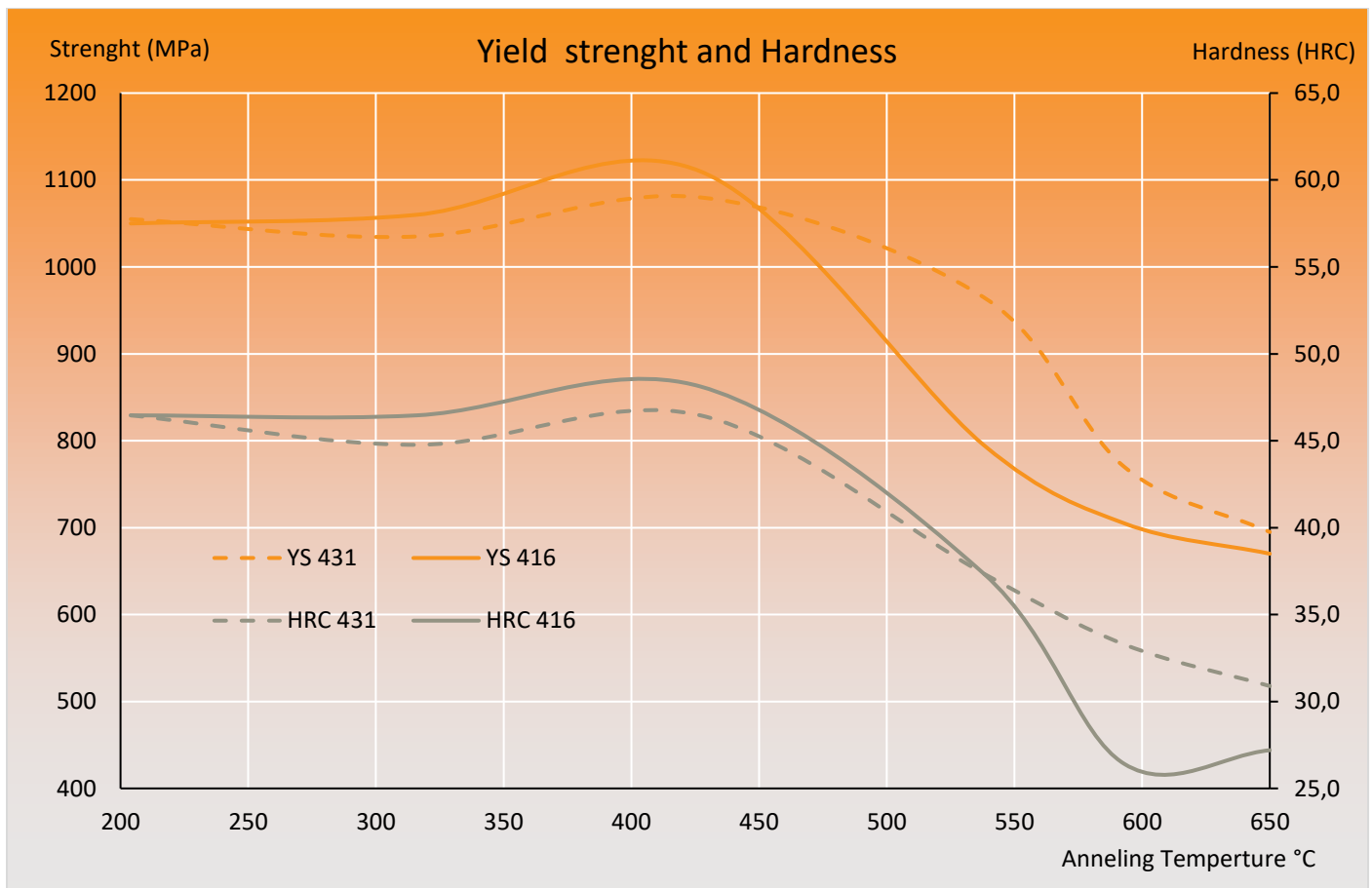


Diagram 1. Yield Strength and hardness curves for AISI 416R and AISI 431.

# 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. Before etching, degrease and clean in acetone.

	Etching solution	Chem. comp.	Blend (%)	Time (min)	Color 431	Color 416
I	Hydrochloric acid 37 %	HCl	100	2-5	Bright	Grey
II	Sulfuric acid 30 %	H <sub>2</sub> SO <sub>4</sub>	100	5-10	Bright	Grey
III	Hydrochloric 37% / Ferro chloride 37%	HCl/FeCl <sub>3</sub>	95 / 5	5	Bright	Grey

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

Etching procedure:

1. Grind the piece progressively up to desired grit, 600 or higher. Finish off with polishing if desired.
2. Degrease the piece carefully and finish off using glass cleaner.
3. Mix the etching acid in the recommended ratios and remember to always pour the acid into the water.
4. Heat the acid mixture in a water bath.
5. Immerse the piece in the mix and leave it in for the time you choose. Longer soaking time will give deeper relief.
6. Neutralize the piece by dipping it into water with bicarbonate.
7. A light buff with 2500 grit or more, after etching, can help to make the tops bright.

Beware of noxious fumes. Etching must be performed in a well-ventilated area. All acids are highly corrosive and must be handled with great care.

## Products dimensions and delivery conditions.

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 and conditions:

- Round bars, dimensions Ø 11-61 mm.
- Annealed condition, hardness < 25 HRC

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