

# DAMASTEEL® DS92X™ GUN BARREL STEEL

## PRODUCT INFORMATION

Damasteel's hardenable gun barrel steel is a RSP (Rapid Solidification Powder) based steel with AISI 4140/4340 as the constituent alloys. The steel is 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 hardenable barrel Damascus patterned steel should be your first choice when it comes to:

- High hardness after hardening and tempering
- High ductility and fatigue properties
- High purity and cleanliness
- Ease of machining

Grade	Etch color	C	Si	Mn	Cr	Mo	P	S	Ni
4140	Dark	0,40	0,20	0,85	1	0,20	0,035	0,040	-
4340	Bright	0,40	0,20	0,70	1	0,20	0,035	0,040	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	440	MPa	Young's modulus	210	GPa
Tensile strength, Rm	690	MPa	Poisson's ratio	0,3	-
Elongation, A5	22	%	Thermal conductivity	43	W/m·K
Hardness	210	HV	Heat capacity	473	J/kg·K
Density	7,85	kg/dm <sup>3</sup>	Linear thermal expansion coefficient, α	12	μm/m·K

Table 2. Mechanical and physical properties of Damasteel DS92X™ in annealed condition.

## Hot working

Hot working temperature 800-1180 °C (1700-2200 F).

## Heat treatment

Annealing at 650 °C (1200 F) for 4 hours.

Normalizing at 870 °C (1600 F), air cooling.

The recommendation is to have the material relaxation annealed before any cold working operations or machining. All material supplied from Damasteel is delivered in annealed condition.

Ac1 temperature 725 °C (1340 F)

Ac3 temperature 805 °C (1480 F)

For all heat treatment processes, a good control of the heating temperature is needed. An electric or gas fired furnace is recommended.

## Welding

Damasteel's barrel steel can be welded using all conventional techniques. However, the mechanical properties of this steel will be affected if it is welded in the heat treated condition, and post weld heat treatment should be performed.

# Machining

The machinability is excellent in annealed condition.

## Machining data

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		14 (45)	0,10 (0,004)	8 (25)	0,08 (0,003)
Drilling, HSS-drill 18 mm		14 (45)	0,20 (0,008)	8 (25)	0,15 (0,006)
Gun drilling, carbide Ø 6 mm (1/4")		120 (385)	0,03 (0,001)	40 (125)	0,004 (0,0002)
Ejection- or STS-drilling Ø 19 mm (3/4")		70 (229)	0,16 (0,006)	40 (131)	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)	40 (131)	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 (500)	0,30 (0,01)	120 (400)	0,30 (0,01)
	4 mm (0,16 in)	120 (400)	0,60 (0,025)	85 (279)	0,60 (0,025)
	8 mm (0,32 in)	90 (300)	0,50 (0,020)	65 (213)	0,50 (0,020)
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)	220 (725)	0,18 (0,007)	150 (485)	0,15 (0,006)
	4 mm (0,16 in)	150 (485)	0,15 (0,006)	105 (345)	0,10 (0,004)
	8 mm (0,32 in)	115 (375)	0,10 (0,004)	81 (265)	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		A60IV	30 (6000)	20 (70)	0,05 (0,002)
Cylindrical finishing		A60IV	30 (6000)	20 (70)	0,013 (0,0005)
Internal grinding		A60JV	30 (6000)	30 (105)	0,013 (0,0005)
Internal finishing		A60JV	30 (6000)	30 (105)	0,005 (0,0002)

Table 3. Machining data for DS92X™

# Hardening

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

	Brinell Hardness (HB)	Approx. tensile strength (MPa)	Hardening	Tempering	Area contraction (%)
I	300	1000 (66 tsi)	845 °C / 1555 F	625 °C / 1157 F	54
II	400	1350 (87 tsi)	845 °C / 1555 F	450 °C / 842 F	50
	500	1800 (112 tsi)	845 °C / 1555 F	250 °C / 482 F	46

Table 4. Hardening and tempering suggestions for a Ø 25 mm bar with corresponding hardness

Harden the bar at 845 °C (1555 F) for 30 min, quench in oil.

Tempering at 170 – 700 °C (340 – 1300 F) for 3 hours. Higher tempering temperature gives better fatigue and ductility properties but lower hardness.

# Surface treatment

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

# Etching

Before etching, close the bore with a rubber cork in the dipped end. Etching before browning improves the pattern and makes it more distinct.

1. Mix the etching acid in one of the below ratios and remember to always pour the acid into the water

	Acid	Chem. comp.	Blend (%)	Time (min)	Color 4340	Color 4140
1	Hydrochloric acid 37 % at 45°C (110 F)	HCl	100	5	Bright grey	Dark grey
2	Sulfuric acid 30 %	H <sub>2</sub> SO <sub>4</sub>	100	20	Light grey	Grey

Table 5. Etching suggestions with corresponding colors and relief of the different alloys

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

2. Put the piece in the mix and leave it in for the time you choose. The suggested times above gave proper results
3. Neutralize the piece by, for example, dip it into water with bicarbonate
4. Clean the piece in water to get rid of any acid residues
5. Make the oxide coating

Etching is done to reveal the pattern on the finished piece. The best conditions for etching are good polished surfaces which are carefully degreased. The work piece is preferably dipped into the etching acid. After etching the piece must be thoroughly cleaned in water. A final cleaning with brush and soap eliminates the risk for acid dwell.

# Oxide coating

## Browning

A blueing treatment will affect the both alloys of the Damascus which makes the pattern indistinct. Instead a browning process is recommended.

Depending on your desired finish, there are several browning recipes to choose from. See for example

- Firearms Blueing and Browning by R.H. Angier, ISBN 978-0-8117-0610-0
- Gun and its Development by W.W. Greener, ISBN 1-58574-734-3

# 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.

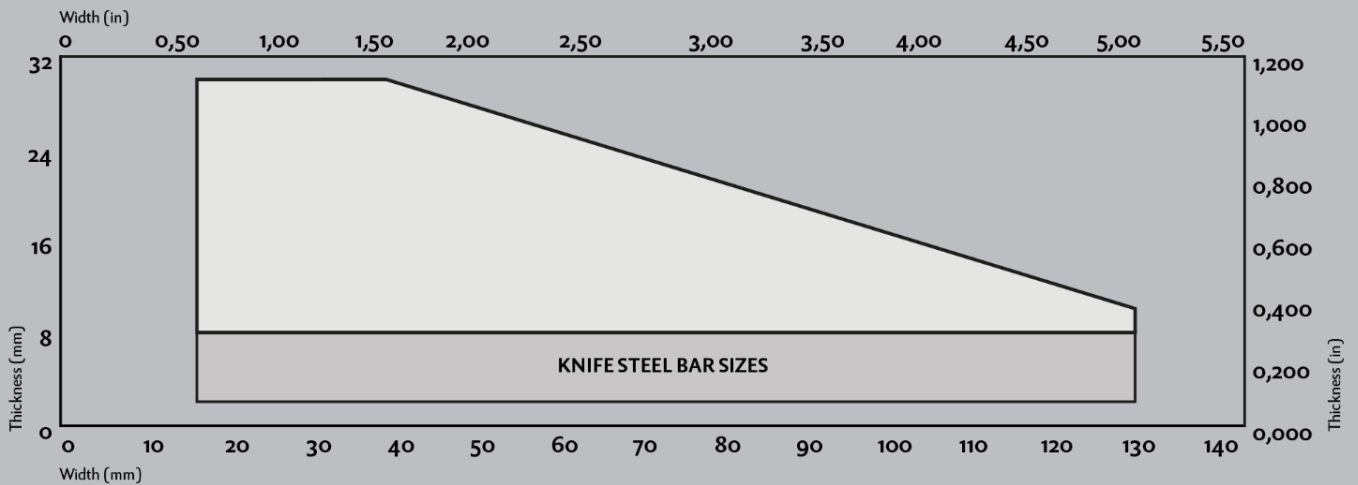


Figure 1: Size range

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<sup>TM</sup>, DS95X<sup>TM</sup>, DS92X<sup>TM</sup>, DS96X<sup>TM</sup>) or our martensitic steels RWL34<sup>TM</sup> or Nitrobe77<sup>TM</sup> – do not hesitate to contact us.

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