

Two damascene steel combinations for Hunting Firearm Barrels

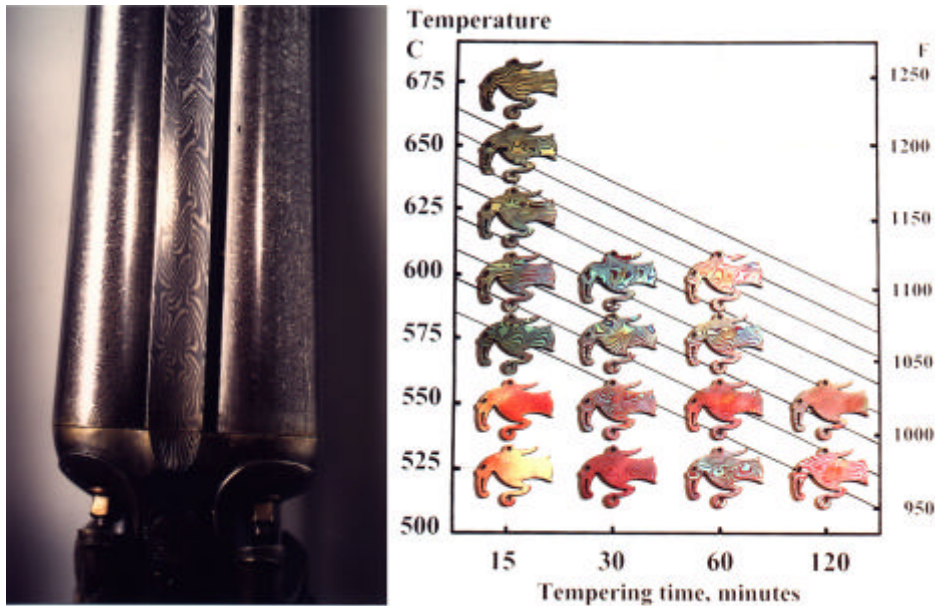
The modern generation damascene steels are developed and made by Damasteel AB, Sweden by Rapid Solidification Powder Technology. This powder method to make damascene patterns is patented in most countries (US Patent No 5 815 790). The new generation barrels are patented (Swedish patent 9900905-2), patent pending in most countries.

The barrel steels 926.x and 968.x are made by hot isostatic pressing of rapidly solidified powders of two compositions compounded in some hundred layers. The patterns are further developed during the forging and rolling down to the desired dimensions.

The rapid solidification gives less segregation and finely distributed microstructure. This means improved ductility and fatigue strength compared to conventional grades.

The modern damascene barrels have gone through a torsion twisting operation. This turns the grain structure towards the transverse direction. The results are still improved ductility and fatigue properties.

Tempering colours of 968.x Stainless Damascus Steel



Material Data for 926.x and 968.x

Steel grade

Compositions Dark etching
Bright etching

Approximate transition temperatures

Forging temperature

Annealing

Normalizing

Hardening

Tempering

Physical properties

Density

Modulus of elasticity

Linear thermal expansion coeff.

Specific heat

Thermal conductivity

Heat treatment of 1" bars for:

300 HB ~ 1000 MPa (66 tsi)

400 HB ~ 1350 MPa (87 tsi)

500 HB ~ 1800 MPa (112 tsi)

926.x Low alloy Damascus Steel

Low alloy hardenable carbon steel

Damascene pattern

For blueing or browning.

AISI 4140; 0,40%C; 1%Cr; 0,2%Mo

AISI 4340; 0,40%C; 1%Cr; 0,2%Mo; 2%Ni

Ac1 725 C (1340 F)

Ac3 805 C (1480 F)

1180 - 800 C (2200 - 1700 F)

650 C (1200 F) for 4 hours

870 C (1600 F) air cooling.

845 C (1555 F) hold 30 min. Oil quench.

170 - 700 C (340 - 1300 F) 3 hours.

7 800 kg/m³ (0,28 lb/in³)

213 GPa (31 000 000 psi)

12 μm/m K (6,7 μin/in F)

473 J/kg K (0,113 Btu/lb F)

43 W/m K (24,6 Btu/ft h F)

Hardening

845 C (1555 F)

" 450 C (842 F)

" 250 C (482 F)

Temper

625 C (1157 F)

" 450 C (842 F)

" 250 C (482 F)

Area contr. %

54%

50%

46%

968.x Stainless Damascus Steel

Hardenable Stainless Steel.

Damascene pattern

For etched patterns.

AISI 416; 0,22%C; 13%Cr; 0,2%S

AISI 431; 0,23%C; 16%Cr; 3%Ni

Ac1 710 C (1310 F)

Ac3 900 C (1652 F)

1150 - 900 C (2100 - 1650 F)

660 C (1220 F) for 5 hours

1040 C (1904 F) 30 min. Oil quench.

230 - 700 C (440 - 1300 F) 3 hours.

7 800 kg/m³ (0,28 lb/in³)

200 GPa (29 000 000 psi)

10 μm/m K (5,5 μin/in F)

460 J/kg K (0,11 Btu/lb F)

25 W/m K (14,4 Btu/ft h F)

Hardening

1040 C (1904 F)

" 375 C (710 F)

" 375 C (710 F)

Temper

565 C (1050 F)

" 375 C (710 F)

" 375 C (710 F)

Product information

Steelgrades 926,x and 968,x

Machining data

Steel grade Hardness	926,x Low alloy Damascus Steel				968,x Stainless Damascus Steel			
	300 HB		400 HB		300 HB		400 HB	
	Speed m/min (ft/min)	Feed mm/rev. (in/rev.)	Speed m/min (ft/min)	Feed mm/rev. (in/rev.)	Speed m/min (ft/min)	Feed mm/rev. (in/rev.)	Speed m/min (ft/min)	Feed mm/rev. (in/rev.)
Drilling, HSS-drill 6mm 18mm	14 (45)	.10 (.004)	8 (25)	.08 (.003)	21 (70)	.13 (.005)	14 (45)	.08 (.003)
Gun drilling, carbide 6 mm (1/4") dia	14 (45)	.20 (.008)	8 (25)	.15 (.006)	21 (70)	.23 (.009)	14 (45)	.18 (.007)
Ejection- or STS-drilling 3/4" dia	120 (385)	.03 (.001)	40 (125)	.004 (.0002)	80 (250)	.03 (.001)	40 (125)	.004 (.0002)
Reaming	100 (310)	.20 (.008)	55 (177)	.14 (.005)	85 (280)	.16 (.006)	40 (125)	.20 (.008)
HSS	mm/tooth (in/tooth)		mm/tooth (in/tooth)		mm/tooth (in/tooth)		mm/tooth (in/tooth)	
Carbide	14 (45)	.03 (.001)	9 (30)	.03 (.001)	14 (45)	.03 (.001)	9 (30)	.03 (.001)
Turning	m/min	mm/rev.	m/min	mm/rev.	m/min	mm/rev.	m/min	mm/rev.
Depth of cut	(ft/min)	(in/rev.)	(ft/min)	(in/rev.)	(ft/min)	(in/rev.)	(ft/min)	(in/rev.)
HSS 1 mm (.04 in)	21 (70)	.13 (.005)	18 (60)	.13 (.005)	30 (100)	.18 (.007)	18 (60)	.13 (.005)
4 mm (.16 in)	17 (55)	.25 (.010)	14 (45)	.25 (.010)	24 (80)	.40 (.015)	15 (50)	.25 (.010)
8 mm (.32 in)	12 (40)	.40 (.015)	11 (35)	.40 (.015)	18 (60)	.50 (.020)	12 (40)	.40 (.015)
Coated 1 mm (.04 in)	150 (500)	.18 (.007)	120 (400)	.18 (.007)	175 (575)	.18 (.007)	90 (300)	.13 (.005)
Carbide 4 mm (.16 in)	120 (400)	.40 (.015)	90 (300)	.40 (.015)	160 (525)	.40 (.015)	76 (250)	.25 (.010)
8 mm (.32 in)	90 (300)	.50 (.020)	76 (250)	.50 (.020)	120 (400)	.50 (.020)	60 (200)	.40 (.015)
Face Milling	m/min	mm/tooth	m/min	mm/tooth	m/min	mm/tooth	m/min	mm/tooth
Depth of cut	(ft/min)	(in/tooth)	(ft/min)	(in/tooth)	(ft/min)	(in/tooth)	(ft/min)	(in/tooth)
HSS 1 mm (.04 in)	32 (125)	.15 (.006)	18 (60)	.10 (.004)	32 (125)	.15 (.006)	18 (60)	.10 (.004)
4 mm (.16 in)	26 (85)	.23 (.009)	15 (50)	.15 (.006)	27 (90)	.23 (.009)	14 (45)	.15 (.006)
8 mm (.32 in)	20 (65)	.30 (.012)	12 (40)	.20 (.008)	21 (70)	.30 (.012)	11 (35)	.20 (.008)
Coated 1 mm (.04 in)	220 (725)	.13 (.005)	150 (485)	.08 (.003)	200 (650)	.13 (.005)	115 (375)	.08 (.003)
Carbide 4 mm (.16 in)	150 (485)	.18 (.007)	105 (345)	.13 (.005)	140 (455)	.18 (.007)	90 (300)	.13 (.005)
8 mm (.32 in)	115 (375)	.23 (.009)	81 (265)	.18 (.007)	110 (355)	.23 (.009)	69 (225)	.18 (.007)
Grinding	Wheel identity	Wheel speed m/s (ft/min)	Work speed m/min(ft/min)	Infeed mm (in)	Wheel identity	Wheel speed m/s (ft/min)	Work speed m/min(ft/min)	Infeed mm (in)
Surface grinding finishing	A46HV "	30 (6 000) "	20 (70) "	.05 (.002) .013 (.0005)	A46HV "	30 (6 000) "	20 (70) "	.05 (.002) .013 (.0005)
Cylindrical grinding finishing	A60IV "	30 (6 000) "	20 (70) "	.05 (.002) .013 (.0005)	A46IV "	30 (6 000) "	20 (70) "	.05 (.002) .013 (.0005)
Internal grinding finishing	A60JV "	30 (6 000) "	30 (105) "	.013 (.0005) .005 (.0002)	A46JV "	30 (6 000) "	30 (105) "	.013 (.0005) .005 (.0002)
Surface treatment	Visible surfaces shall be carefully polished. Degrease and clean in Acetone.				Visible surfaces shall be carefully polished. Degrease and clean in Acetone.			
Etching	Before treatment, close the bore with a rubber cork in the dipped end. Etching before the bluing improves the pattern and makes it more distinct. Use 30 % HCl, heated to 45 C (113 F). The 30% H2SO4 normally used for car accumulators is a good alternative.				Before treatment, close the bore with a rubber cork in the dipped end. Use 30 % HCl. The 30% H2SO4 normally used for car accumulators is a good alternative. Etch until there is a good relief. Test the surface pattern by scratching a stick on the surface. Then you can feel how the deep etch is progressing.			
Oxide coatings	There are two methods for making an oxide coating. Hot black oxidation or cold blueing- browning.				Warning, the acids and other chemicals must be handled with care.			
Hot Black Oxidation	Rifle barrels are normally black oxidized in a boiling sodium nitrite hydroxide solution at 138 C ((280 F). Follow the normal instructions but use short immersing times. Then a colourful damascene coating in blue and red is developed.				Stainless barrels are normally etched and polished for a metal damascus etched surface. No rust protection is needed. One alternative for making a coloured surface on a stainless barrel is tempering.			
Cold Blueing-Browning	Soldered shotgun barrels can not be hot oxidized. There are many room temperature blueing agents. They are based on phosphating solutions or chlorides in nitric acid. To ensure a clearly visible pattern, use diluted solutions and short immersion times. Pre-etching is important. Warning, the chemicals must be handled with care.				The picture on the previous page, shows how the colours depend on temperature and time. The background lines in the tells about the tempering effect on the steel hardness. (Fifteen minutes at 650C (1200F) has the same effect on the hardness as three hours at 600C (1100 F)).			