# DAMASTEEL AB

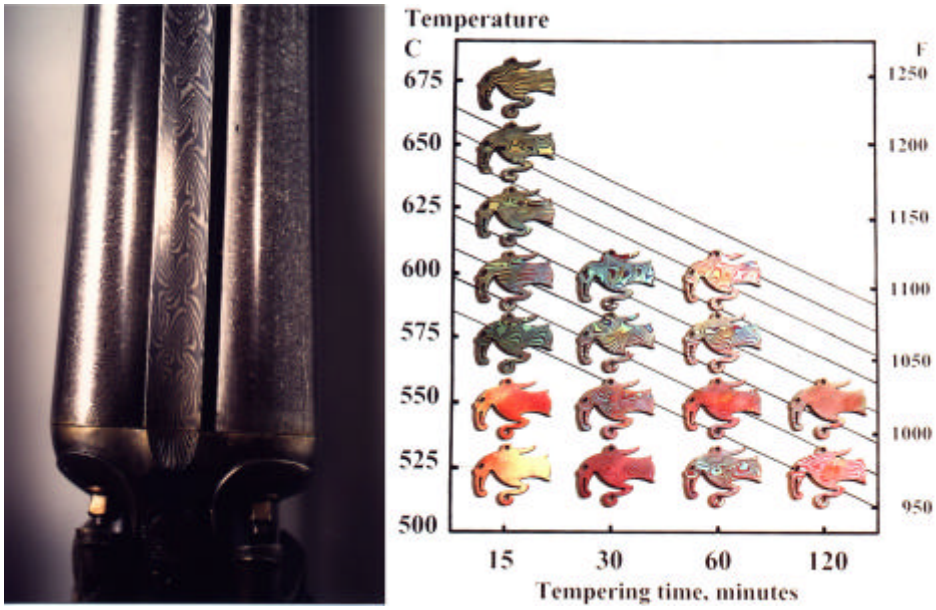
# Product information

**Steelgrades 926,x and 968,x**

## 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 | 926.x Low alloy Damascus Steel | | | 968.x StainlessDamascus Steel | |
|---|---|---|---|---|---|
| | **Low alloy hardenable carbon steel**<br>**Damascene pattern**<br>**For blueing or browning.** | | | **Hardenable Stainless Steel.**<br>**Damascene pattern**<br>**For etched patterns.** | |
| **Compositions** Dark etching | **AISI 4140; 0,40%C; 1%Cr; 0,2%Mo** | | | **AISI 416; 0,22%C; 13%Cr; 0,2%S** | |
| Bright etching | **AISI 4340; 0,40%C; 1%Cr; 0,2%Mo; 2%Ni** | | | **AISI 431; 0,23%C; 16%Cr; 3%Ni** | |
| **Approximate transition temperatures** | Ac1 725 C (1340 F)<br>Ac3 805 C (1480 F) | | | Ac1 710 C (1310 F)<br>Ac3 900 C (1652 F) | |
| **Forging temperature** | 1180 - 800 C (2200 - 1700 F) | | | 1150 - 900 C (2100 - 1650 F) | |
| **Annealing** | 650 C (1200 F) for 4 hours | | | 660 C (1220 F) for 5 hours | |
| **Normalizing** | 870 C (1600 F) air cooling. | | | | |
| **Hardening** | 845 C (1555 F) hold 30 min. Oil quench. | | | 1040 C (1904 F) 30 min. Oil quench. | |
| **Tempering** | 170 - 700 C (340 - 1300 F) 3 hours. | | | 230 - 700 C (440 - 1300 F) 3 hours. | |
| **Physical properties** | | | | | |
| **Density** | 7 800 kg/m3 (0,28 lb/in3) | | | 7 800 kg/m3 (0,28 lb/in3) | |
| **Modulus of elasticity** | 213 GPa (31 000 000 psi) | | | 200 GPa (29 000 000 psi) | |
| **Linear thermal expansion coeff.** | 12 µm/m K (6,7 µin/in F) | | | 10 µm/m K (5,5 µin/in F) | |
| **Specific heat** | 473 J/kg K (0,113 Btu/lb F) | | | 460 J/Kg K (0,11 Btu/lb F) | |
| **Thermal conductivity** | 43 W/m K (24,6 Btu/ft h F) | | | 25 W/m K (14,4 Btu/ft h F) | |
| **Heat treatment of 1" bars for:** | **Hardening** | **Temper** | **Area contr. %** | **Hardening** | **Temper** |
| **300 HB** ~ 1000 MPa (66 tsi) | 845 C (1555 F) | 625 C (1157 F) | 54% | 1040 C (1904 F) | 565 C (1050 F) |
| **400 HB** ~ 1350 MPa (87 tsi) | " | 450 C (842 F) | 50% | " | 375 C (710 F) |
| **500 HB** ~ 1800 MPa (112 tsi) | " | 250 C (482 F) | 46% | | |

# Product information

**Steelgrades 926,x and 968,x**

## Machining data

| **Steel grade** | **926,x Low alloy Damascus Steel** | | | | **968,x Stainless Damascus Steel** | | | |
|---|---|---|---|---|---|---|---|---|
| **Hardness** | **300 HB** | | **400 HB** | | **300 HB** | | **400 HB** | |
| | **Speed** | **Feed** | **Speed** | **Feed** | **Speed** | **Feed** | **Speed** | **Feed** |
| | m/min (ft/min) | mm/rev. (in/rev.) | m/min (ft/min) | mm/rev. (in/rev.) | m/min (ft/min) | mm/rev. (in/rev.) | m/min (ft/min) | mm/rev. (in/rev.) |
| **Drilling, HSS-drill 6mm** | 14 (45) | .10 (.004) | 8 (25) | .08 (.003) | 21 (70) | .13 (.005) | 14 (45) | .08 (.003) |
| **18mm** | 14 (45) | .20 (.008) | 8 (25) | .15 (.006) | 21 (70) | .23 (.009) | 14 (45) | .18 (.007) |
| **Gun drilling, carbide** | | | | | | | | |
| **6 mm (1/4") dia** | 120 (385) | .03 (.001) | 40 (125) | .004 (.0002) | 80 (250) | .03 (.001) | 40 (125) | .004 (.0002) |
| **Ejection- or** | | | | | | | | |
| **STS-drilling 3/4" dia** | 100 (310) | .20 (.008) | 55 (177) | .14 (.005) | 85 (280) | .16 (.006) | 40 (125) | .20 (.008) |
| **Reaming** | mm/tooth (in/tooth) | | mm/tooth (in/tooth) | | mm/tooth (in/tooth) | | mm/tooth (in/tooth) | |
| **HSS** | 14 (45) | .03 (.001) | 9 (30) | .03 (.001) | 14 (45) | .03 (.001) | 9 (30) | .03 (.001) |
| **Carbide** | 18 (60) | .03 (.001) | 12 (40) | .03 (.001) | 18 (60) | .03 (.001) | 12 (40) | .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** | A46HV | 30 (6 000) | 20 (70) | .05 (.002) | A46HV | 30 (6 000) | 20 (70) | .05 (.002) |
| **finishing** | " | " | " | .013 (.0005) | " | " | " | .013 (.0005) |
| **Cylindrical grinding** | A60IV | 30 (6 000) | 20 (70) | .05 (.002) | A46IV | 30 (6 000) | 20 (70) | .05 (.002) |
| **finishing** | " | " | " | .013 (.0005 | " | " | " | .013 (.0005) |
| **Internal grinding** | A60JV | 30 (6 000) | 30 (105) | .013 (.0005) | A46JV | 30 (6 000) | 30 (105) | .013 (.0005) |
| **finishing** | " | " | " | .005 (.0002) | " | " | " | .005 (.0002) |

| | | |
|---|---|---|
| **Surface treatment** | Visible surfaces shall be carefully polished.<br>Degrease and clean in Acetone. | Visible surfaces shall be carefully polished.<br>Degrease and clean in Acetone. |
| **Etching** | Before treatment, close the bore with a rubber cork in the dipped end.<br>Etching before the bluening improves the pattern and makes it more distinct.<br>Use 30 % HCl, heated to 45 C (113 F).<br>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.<br>Use 30 % HCl.<br>The 30% H2SO4 normally used for car accumulators is a good alternative.<br>Etch until there is a good relief. Test the surface pattern by scratcing a stick on the suface.<br>Then you can feel how the deep etch is progressing.<br>**Warning. the acids and other chemicals must be handeled with care.** |
| **Oxide coatings** | There are two methods for making an oxide coating. Hot black oxidation or cold blueing-browning. | |
| **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.<br>No rust protection is needed.<br>One alternative for making a coloured surface on a stainless barrel is tempering. |
| **Cold Blueing-Browning** | Soldered shotgun barrels can not be hot oxidized.<br>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.<br>**Warning, the chemicals must be handled with care.** | The picture on the previous page, shows how the colours depend on temperature and time.<br>The background lines in the tells about the tempering effect on the steel hardness.<br>(Fifteen minutes at 650C (1200F) has the same effect on the hardness as three hours at 600C (1100 F)). |