

DAMASTEEL® NITROBE77™ MARTENSITIC STEEL

PRODUCT INFORMATION

Damasteel's martensitic stainless Nitrobe77™ is a powder based hardenable steel which solves two traditional knife problems:

- Sharp edges on chef knives. Nitrobe77™ is dishwasher safe without risk of corrosion or edge damages
- Sharp edges on hunters knives. Can be forgotten in the sheath without the hunter being hit by self-reproach

The alloy represents an outstanding combination of corrosion resistance and edge strength. This combination of properties is a reason for its revolutionary suitability as knife material.

Some other benefits with the Damasteel Nitrobe77™ are:

- Nitrogen replaces Carbon as martensite initiator in the hardening process. This has given the steel radically improved corrosion properties. The final product is a unique combination of edge strength and corrosion resistance.
- It is made from Rapid Solidification Powder (RSP) to reduce the sizes and quantities of unfavorable solidification structures
- Alloyed with Chromium for corrosion resistance
- Niobium gives fine grain structures regardless of hardening temperature

Grade	C	N	Cr	Mo	V	Nb
Nitrobe77™	0,10	0,90	14,5	3,0	0,10	0,50

Table 1. Nominal chemical compositions in wt-% of Nitrobe77™

Mechanical and physical properties

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

Hardness	10-20	HRC	Young's modulus	230	GPa
Density	7,78	kg/dm ³	Poisson's ratio	0,32	-

Table 2. Mechanical and physical properties of Damasteel martensitic stainless Nitrobe77™ in annealed condition.

Hardness between 10-20 HRC is depending on which kind of annealing, see section *Heat treatment*

Corrosion resistance

Damasteel's Nitrobe77™ has outstanding corrosion properties and can be used for many types of applications where edge strength and high corrosion resistance are desirable.

Hot working

Hot working temperature 1150 °C (2100 F).

Melting starts at 1220°C (2230 F) which means that the material is sensitive to overheating. Good control of the heating temperature is needed. An electric or gas fired furnace is recommended.

Long soaking times above 850°C (1560 F) leads to "denitrizing" (compare with decarburization for carbon steels).

Nitrobe77™ is somewhat softer and easier to forge than the carbon alloyed knife steels.

To prevent risk of cracking, allow the material to cool slowly after any hot working process.

Cold working

Martensitic stainless steels does not cold work as easily as the conventional austenitic stainless steels but can be formed and fabricated by a full range of cold working operations. The cold working ductility is good and any cold working process will increase the strength and the hardness of the material.

Heat treatment

After the hot working process the Nitrobe77™ hardens and will therefore need to be annealed before further machining.

Ferritic annealing at 700 °C (1300 F) for 4 hours lowers the hardness from >50 to 20 HRC.

Austenitic annealing at 900 °C (1650 F) for one hour and then slow cooling (approx. 8 hours) to 650 °C (1200 F). This annealing lowers the hardness from >50 to 10-15 HRC.

Annealing in a vacuum furnace is not recommended since Nitrogen will diffuse from the steel and leaves the surface with a lower Nitrogen content. Air or Nitrogen atmosphere is better.

Supplied Nitrobe77™ from Damasteel is annealed to 10-20 HRC hardness.

Machining

Rough machining can be advantageously conducted in soft annealed condition. This is no different than with traditional knife steels.

As with the conventional austenitic stainless steels, the martensitic steels have some specific machinability properties. The martensitic stainless steels are generally easier to machine than other stainless steel grades. The machining characteristics for our martensitic stainless Nitrobe77™ are

- Low tensile strength but a strong work hardening
- Tendencies for buildup of material on the tool edge
- Tough and stringy chips can be prevented by using chip curler tools

Grinding and polishing

Normal grinding and polishing procedures for austenitic stainless can be used also for the martensitic stainless steel.

Grinding wheel recommendation:

Silicon Carbide, 46 grit, soft, open density, ceramic bonded. (C46J6V)

- Speed: 35 m/sec
- Feed: 0.01-0.05 mm/stroke

Speed of the work piece may be 1/60 of the grinding speed.

Hardening

1. Hold time at the hardening temperature
2. Quenching, rapid cooling to room temperature
3. Cryogenic treatment, deep freezing. You can use temperatures up to -15°C (0 F) but as cold as possible is better for the result
4. Tempering

Hardening or tempering in vacuum is not recommended since the Nitrogen will diffuse from the steel and leaves the surface with a somewhat lower Nitrogen content.

Quenching from hardening temperature, Nitrobe77™ sets moderates demands for rapid quenching. The cooling rate until below 800 °C (1470 F) must be > 7 °C/sec (45 F/sec) to avoid any other phases like perlite or bainite to form. When quenching knife blades it is sufficient to squeeze the blade between two cooled clamping jaws directly from the furnace. That way you can keep the straightness and flatness under control.

All hardening and tempering times are tested for at 3,2 mm thick piece. Increase or decrease that time with one minute per half mm of thickness.

Tempering

Nitro77™ can be tempered either with a low- or a high temperature tempering.

Low temperature tempering

For knife applications the following heat treatments can be recommended for a 3,2 mm thick piece.

	Holding time 5 min at (A) temperature	Quenching to room temperature	Deep freezing at -15°C (o F) for 0,5 h	Tempering at 170 °C for 1 h	Deep freezing at -15°C (o F) for 0,5 h
I	1060 °C/1940 F	59 HRC	57 HRC	59 HRC	58 HRC
II	1080 °C/1980 F	60 HRC	58 HRC	60 HRC	59,5 HRC
III	1100 °C/2010 F	59 HRC	59 HRC	62 HRC	61,5 HRC
IV	1120 °C/2050 F	58 HRC	56 HRC	61 HRC	61 HRC

Table 3. Hardening and tempering suggestions for a 3,2 mm thick piece with corresponding hardness of the steel

These measurements gives an impression that freezing decreases the hardness. But, it is needed one time. The last freeze can be excluded. The surface will be somewhat denitrified after hardening and tempering so if you grind down a little after the heat treatment, the hardness will be 1-2 HRC higher.

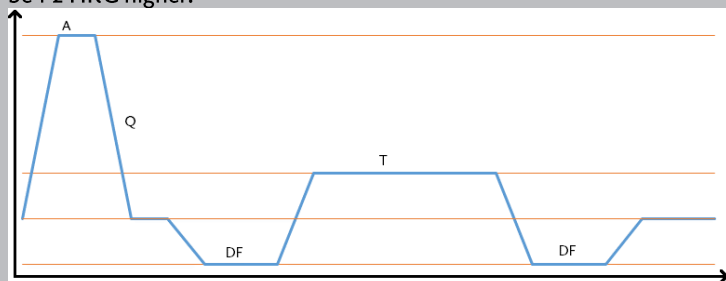


Figure 1: Schematic hardening and tempering curve for low temperature tempering

Low temperature tempering

- + Easy hardening equipment and hardening procedure.
- + Best corrosion resistance
- The knife will be sensitive to high temperatures

High temperature tempering

For knife applications the following heat treatments can be recommended for a 3,2 mm thick piece.

	Quenching from temperature (A)	Deep freezing at -196 °C (-320 F) for 0,5 hours and tempering for 3x1 hours at		
		460 °C (860 F)	480 °C (900 F)	500 °C (930 F)
I	1075 °C/1970 F	61,5 HRC	61,5 HRC	61,5 HRC
II	1100 °C/2010 F	62 HRC	62 HRC	62 HRC
III	1125 °C/2060 F	62,5 HRC	62 HRC	62 HRC
IV	1150 °C/2100 F	62 HRC	62,5 HRC	62,5 HRC

Table 4. Hardening and tempering suggestions for a 3,2 mm thick piece with corresponding hardness of the steel

As with the low temperature tempering, there is no need to go straight from tempering temperature to deep freezing but shorter time will increase hardness. The last freeze can be excluded.

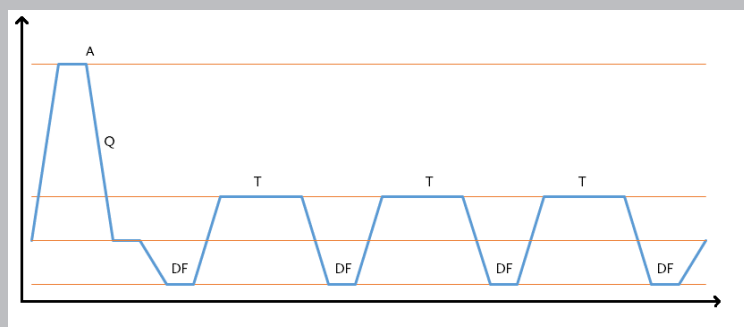


Figure 2: Schematic hardening and tempering curve for high temperature

High temperature tempering

- + Higher and more defined yield strength gives a very stable edge strength on the knife
- A little lower corrosion resistance

Products and dimensions

Damasteel has a standard product program that can be found on our website www.damasteel.com.

We supply Nitrobe77™ in following formats

- Flat bars in selected sizes



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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