

DATASHEET

DAMACORE® DC21R



Product information

Damasteel's stainless Damascus patterned steel, Damacore® DC21R is a powder metallurgy-based steel with two different alloys. The center core consists of RWL34™, a particular successful product with very high strength and toughness combined with extreme edge sharpness. The Damascus patterned outer layers consists of RWL34™ and PMC27™. The addition of Molybdenum in RWL34™ gives our Damascus patterned steel a higher corrosion resistance compared to standard martensitic stainless steels. The two alloys combined in Damasteel's process gives the Damacore® DC21R a beautiful bright look and a mirror finish core.

Distinctive feature

- Mirror finish core of RWL34™
- Easy to grind and polish
- Highest cleanliness level with no inclusions

Mechanical and physical properties

Grade	C	Si	Mn	Cr	Mo	V	S	P	N
RWL34™	1,05	0,50	0,50	14	4	0,2	<0,03	<004	<0,1
PMC27™	0,60	0,50	0,50	13	-	-	<0,03	<0,04	<0,1

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

Yield strength, Rp 0,2	270	MPa	Young's modulus	200	GPa
Tensile strength, Rm	<700	MPa	Poisson's ratio	0,3	-
Elongation, A5	45	%	Thermal conductivity	15	W/m·K
Hardness	<300	HV	Heat capacity	460	J/kg·K
Density	7,8	kg/dm3	Electrical resistivity	0,73	μΩ·m

Table 2. Mechanical and physical properties of Damascus patterned steel (DC21R™) in annealed condition at 20°.

Hot working

Forging or rolling temperature is in the range 1050-1160 °C (1920-2120 F). Melting starts at 1220°C (2230 F) which means that the material is very sensitive to overheating, so good control of the heating temperature is needed. Compared to low alloyed steels, martensitic stainless steels have higher, almost doubled deformation resistance. Long soaking times above 850°C (1560 F) leads to decarburization and scale formation. After the hot working process, a slow cooling is recommended due to the risk of cracks when the material phase transforms to martensite at around 200 °C (390 F). Usage of vermiculite or other heat insulating material is recommended.

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

Cold working

Martensitic stainless steel 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 ductility is good, any cold working process will increase the strength and the hardness of the material.

Machining

The martensitic stainless steels are generally easy to machine. The machining characteristics for our stainless Damascus patterned steel are:
Soft annealed, <25 HRC: Use HSS or carbide tools. Tendencies for buildup on the tool edge. Tough and stringy chips
Hardened and tempered, 56-61 HRC: Ceramic or CBN inserts (milling and turning)

Grinding and polishing

Normal grinding and polishing procedures can be used 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.

Welding

When cooling martensitic stainless steel after any hot process the martensitic phase transformation occur at around 200 °C and can lead to cracking. This can be avoided either by preheating the piece or do a post-weld heat treatment. Our stainless Damascus patterned steel can be welded by a full range of conventional welding methods.

Heat treatment

Annealing:

The recommendation is to have the material fully transformation annealed which means two hours at 910 °C (1670F), then cool in furnace to 750°C (1380F) with a ramp of <15° per hour. Hold for two hours at 750°C (1380F) then air cool to room temperature. Achieved hardness <250 HV (23HRC).

Hardening/ Tempering:

Austenitizing. Holding time at austenitizing temperature 15 min.

Rapid cooling to 50°C. We suggest quenching in oil and that the piece reaches 50°C within two minutes.

Tempering. Between 150°C to 450°C without losing corrosion resistant and for knife applications the following heat treatments can be recommended, see table 3 below.

Deep freezing is not necessary but completes the martensite transformation and increases hardness. Hold for 2h in temperature below -100°C(-148F) or in Liquidized Nitrogen -198°C (-324F) a half an hour. For knife applications the following heat treatments, I to V, can be recommended.

	Austenitizing	Tempering	Tempering	HardnessRWL34™	Hardness
I	1050 °C / 1920 F	220 °C / 430 F	2	59 HRC	53 HRC
II	1050 °C / 1920 F	175 °C / 345 F	2	62 HRC	54 HRC
III	1080 °C / 1980 F	220 °C / 430 F	2	58 HRC	56 HRC
IV	1080 °C / 1980 F	175 °C / 345 F	2	63 HRC	58 HRC
V	1100 °C / 2010 F	175 °C / 345 F	2	64 HRC	60 HRC

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

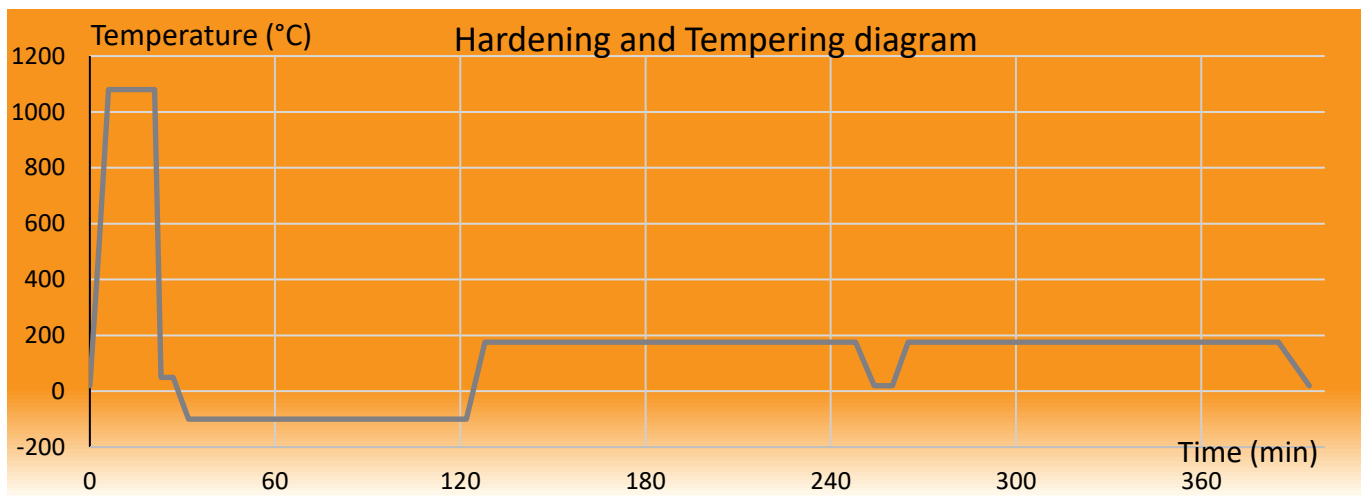


Diagram 1. Schematic hardening and tempering diagram for martensitic material including a deep-freezing treatment with liquified Nitrogen.

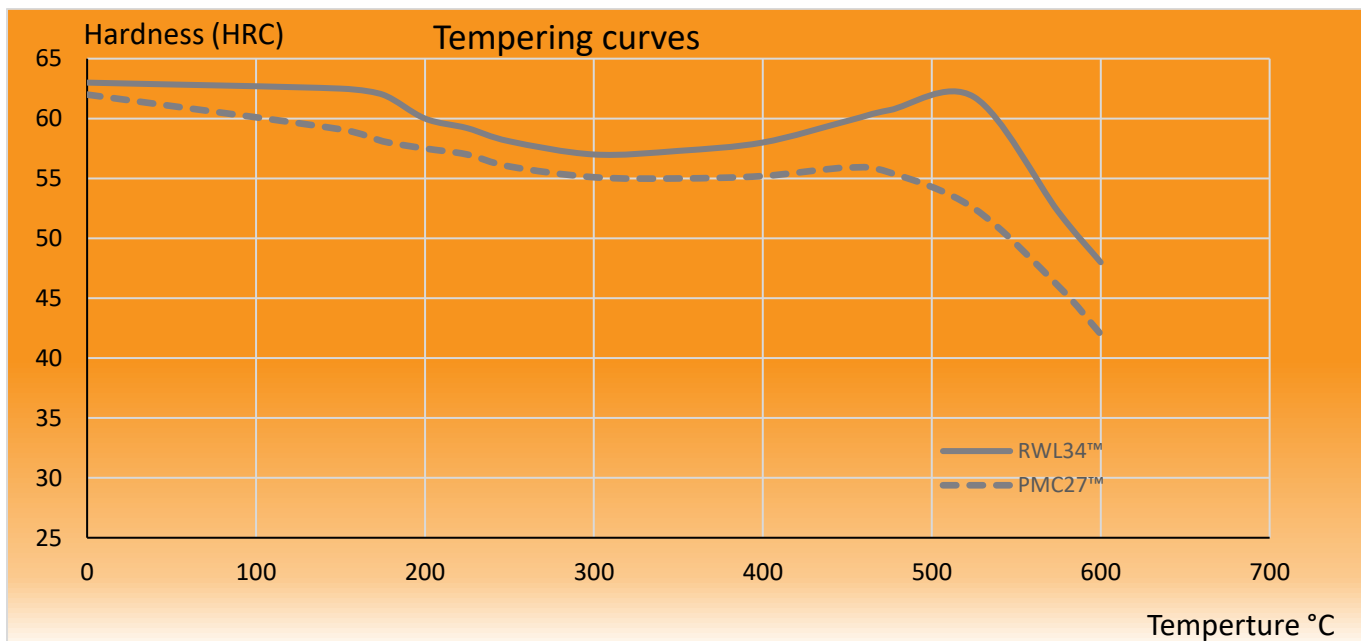


Diagram 2. Tempering diagram for RWL34™ and PMC27™.

Etching

To make the pattern in our steel visible, etching must be done. 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 some suggestions.

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

Etching procedure:

1. Grind the piece progressively up to desired grit, 600 or higher. Finish off with polishing if desired.
2. Clean and degrease the piece carefully.
3. Mix the etching acid in the recommended ratios and remember to always pour the acid into the water.
4. Immerse the piece in the mix and leave it in for the time you choose. Longer soaking time will give deeper relief.
5. Neutralize the piece by dipping it into water with bicarbonate.

	Etching Solution	Chem. comp.	Blend (%)	Time (min)	Color RWL34™	Color PMC27™
I	Hydrochloric acid 37 %	HCl	100	2-5	Bright grey	Light grey
II	Sulfuric acid 30 %	H ₂ SO ₄	100	5-10	Light grey	Grey
III*	Hydrochloric acid 37 %/ Ferro chloride 30 %	HCl/ FeCl ₃	95/5	5-10	Bright grey	Dark grey

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

* Method number III is a high contrast etching which requires two steps. First, etch in HCl then neutralize then directly afterwards etch in the mix of Vinegar and FeCl₃. A light buff at the end can help to make the tops bright.

Products and dimensions

Available width on Damacore® DC21R is 38, 51 and 63,5 mm (1,5", 2" and 2,5"). Thicknesses ranging between 2,5 mm to 6,3 mm (0.100" to 0.248"), depending on pattern all thicknesses are not available, se table 3, Length between 500-1100 mm. For more details visit our website.

Patterns	Thickness available for a specific pattern						
	.100" 2,5mm	.118" 3,0mm	.125" 3,2mm	.138" 3,5mm	.156" 4,0mm	.190" 4,8mm	.248" 6,3mm
Odins Eye™					x	x	x
Grosserosen™					x	x	x
Thor™				x	x	x	
Hugin™	x	x	x	x	x	x	
Rose™	x	x	x	x	x	x	
Hakkapella™	x	x	x	x	x	x	x
Baldur™		x	x	x	x	x	x

Tabell 5: Available patterns for a specific thickness.

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