

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 particularly successful product with very high strength and toughness combined with extreme edge sharpness. The Damascus-patterned outer layers consist of RWL34[™] and PMC27[™]. The addition of Molybdenum in RWL34[™] gives our Damascus patterned steel a higher corrosion resistance compared to standard martensitic stainless steel. The two alloys combined in Damasteel's process give 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	<25	HRC	Heat capacity	460	J/kg·K
Density	7,8	kg/dm ³	Electrical resistivity	0,73	μ·Ω·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) lead to decarburization and scale formation. After the hot working process, 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, or machining should be done after hot working until the material is annealed. All material from Damasteel is in the annealed condition.

Cold working

Martensitic stainless steel does not cold work as easily as the conventional austenitic stainless steel, 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. The speed of the workpiece may be 1/60 of the grinding speed.

Welding

When cooling martensitic stainless steel after any hot process, the martensitic phase transformation occurs at around 200 °C and can lead to cracking. This can be avoided either by preheating the piece or doing 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 (1670°F), then cool in the furnace to 750°C (1380°F) with a ramp of <15° per hour. Hold for two hours at 750°C (1380°F), then air cool to room temperature. Achieved hardness <25 HRC.

Hardening/ Tempering:

Austenitizing. Holding time at austenitizing temperature 15 min.

We suggest cooling in **oil** and the piece reaches 50°C within two min. **Cooling in air also works.** Apply some pressure on the piece if cooling in air, so it will not bend due to uneven cooling.

Tempering. Between 150°C and 450°C without losing corrosion resistance, 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 a temperature below -100°C(-148F) or in Liquid Nitrogen at -198°C (-324F) for half an hour. For knife applications, the following heat treatments, I to V, can be recommended.

	Austenitizing temperature	Tempering temperature	Tempering time (h)	Hardness RWL34™ (HRC)	Hardness PMC27™ (HRC)
I	1050 °C / 1920 F	220 °C / 430 F	2	59	53
II	1050 °C / 1920 F	175 °C / 345 F	2	62	54
III	1080 °C / 1980 F	220 °C / 430 F	2	58	56
IV	1080 °C / 1980 F	175 °C / 345 F	2	63	58
V	1100 °C / 2010 F	175 °C / 345 F	2	64	60

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

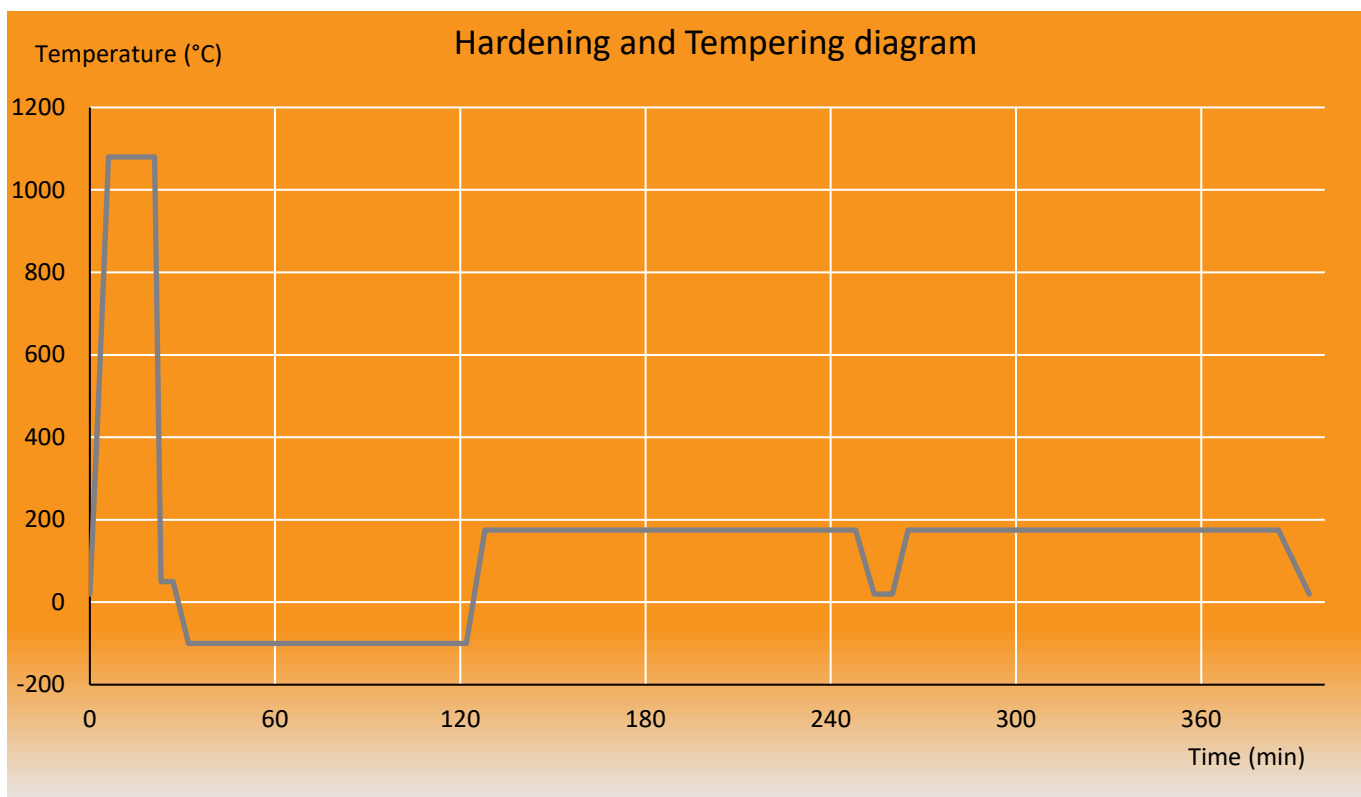


Diagram 1. Schematic hardening and tempering diagram for martensitic material, including a deep-freezing treatment with liquified Nitrogen.

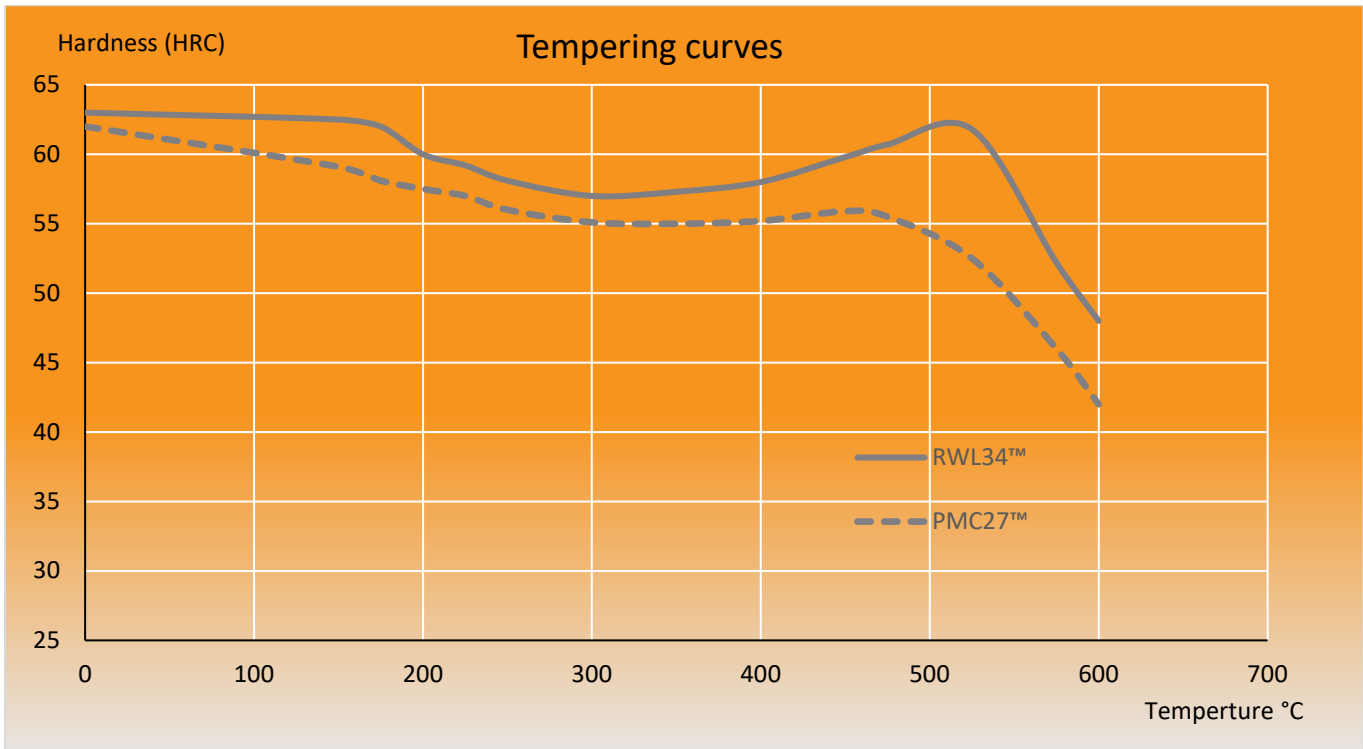


Diagram 2. Tempering diagram for RWL34™ and PMC27™.

Etching

To make the pattern in our steel visible, etching must be done. Depending on the desired result, different acids and acid mixtures can be used. The surface finish is also influencing the result. In the table below are some suggestions.

	Etching Solution	Chem. comp.	Blend (%)	Time (min)	Temp (°C/ °F)	Color RWL34™	Color PMC27™
I	Hydrochloric acid 37% Ferro Chloric acid 40%	HCl, FeCl ₃	95 5	2-5	45-50/ 113-122	Bright	Dark Grey

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

Etching procedure:

1. Grind the piece progressively up to the desired grit, 600 or higher. Finish off with polishing if desired.
2. Degrease the piece carefully and finish off using glass cleaner.
3. Mix the etching acid in the recommended ratios and remember always to pour the acid into the water.
4. Heat the acid mixture in a water bath.
5. Immerse the piece in the mix and leave it in for the time you choose. A longer soaking time will provide deeper relief.
6. Neutralize the piece by dipping it into water with bicarbonate.
7. A light buff with 2500 grit or more, after etching, can help to make the tops bright.

Beware of noxious fumes. Etching must be performed in a well-ventilated area. All acids are highly corrosive and must be handled with great care.

Product dimensions and delivery conditions.

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, see table 3.

Length between 305-610 mm.

Annealed to hardness <28 HRC.

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

Table 5: Available patterns for a specific thickness.

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