High-toughness cold work steel for cutting and forming high-strength sheets, as well as for machine knives.

TENASTEEL®℗ was specifically designed to replace the material 1.2379/X 153 CrMoV 12, which is widely used in this application but can be brittle at times.

TENASTEEL®℗ is an 8% chromium steel that can be excellently nitrided or coated.
Machining in the hardened state is noticeably better than with 1.2379 or 1.2436. Often, TENASTEEL®℗ is an economical alternative to expensive PM steels.

Color Coding:

Black/Blue (TENASTEEL®℗)

TENASTEEL

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EroBlock®

Erodable blocks with a guaranteed vertical grain direction

Implementation and tolerances:

Width + Length: precision milled +0.5 / -0mm

Thickness: ground +0.5 / -0mm

Vacuum-hardened for the best toughness and tool life. Hardening temperature 1050°C, after quenching, tempered twice at 575°C to achieve an optimal hardness of 58 HRC. The heat treatment allows for easy subsequent PVD coating or nitriding treatment.

price per piece

	thickness [mm]			
Square	***30***	***40***	***50***	***150***
120 mm	122	137	153	308
250 mm		373		

Discontinued dimension, available only while supplies last. As a custom order, always available upon request.

Stock and custom dimensions available with starter hole drilling. Special dimensions and alternative materials available upon request.

Raw material

Sheets or blanks thereof
Rolled according to EN 10020 Class C or forged

	thickness [mm]									
	9	11.3	13.4	16.7	22.4	27.7	32.7	44	54	65

- We cut blanks according to your specifications.
- Available pre-processed as VarioPlan®.
- EroBlock ready-hardened in stock.

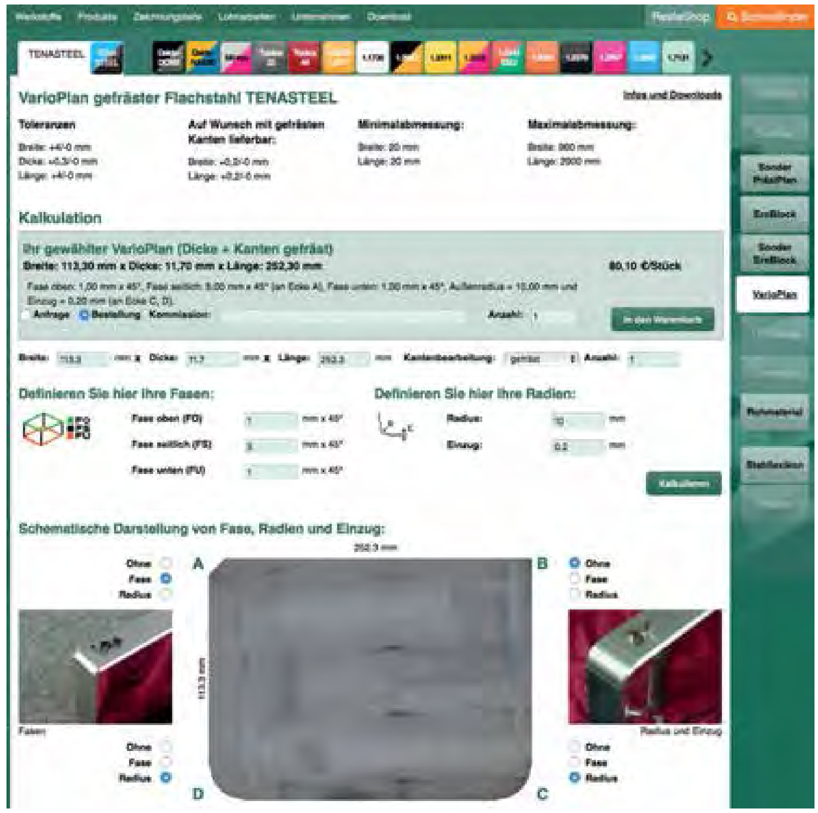
Select affordable raw materials online, including custom cutting options: www.ResteShop.de

VarioPlan®

Precision-machined semi-finished products in freely selectable dimensions.

- Flexible in width, thickness, and length
- Edges sawn or milled
- Available with bevels and/or corner radii upon request
- Production in 2 to 3 days
- Easy calculation

Use our online calculation tool on our webshop: **www.varioplan.de**



TENASTEEL®℗ is a cold work steel that combines high compressive strength with outstanding toughness. It is characterized by high thermal resistance and good machinability in its as-delivered condition. This material is supplied in an annealed state with a maximum hardness of 250HB.

It has been specifically designed to replace the material 1.2379 / X 153 CrMoV 12, which is widely used in this application but can be prone to breakage. TENASTEEL®℗ addresses many tool life issues, especially with edge breakage or cracking seen in 1.2379. Due to its alloy composition and appropriate heat treatment, TENASTEEL®℗ is particularly suitable for surface coatings.

For more detailed information on metallurgy, heat treatment, and the application of TENASTEEL®℗, please refer to the TENASTEEL®℗ Handbook, available online at **www.stahlnetz.de/downloads**.

TENASTEEL®℗ is a trademark product of the French manufacturer Industeel. Gebrüder Recknagel exclusively distributes TENASTEEL®℗ in Germany.

® Registered trademark of Industeel
℗ Patented variety

Standard

Industeel: TENASTEEL®℗

EURONORM: family of X 110 CrMoV

chemical composition [%]

	C	S max	Mn	Cr	Mo	V	others
	1.00	0.005	0.35	7.50	2.60	0.30	Ti

Typische Werte gemäß dem Lastenheft 2001 / 06 / 08MJ1

mechanical properties
(typical values)

hardness [HB] in annealed condition
250 HB max

hardness [HRC] in treated condition	*modulus of elasticity [MPa]*	*compressive strength [MPa]*	*impact toughness [J/cm²] (*)*
56	205	2 210	40
62	205	2 550	25

*unnotched samples

physikal properties

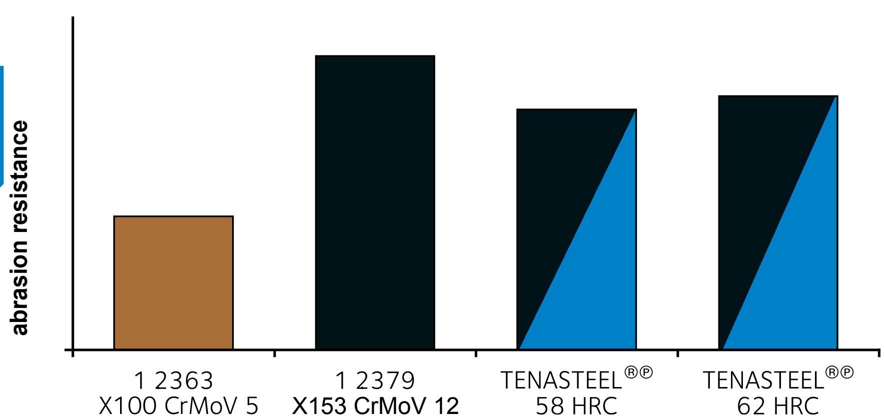
thermal conductivity 20 °C [$W \cdot m^{-1} \cdot K^{-1}$]	*average coefficient of thermal expansion [10 -6 K^{-1}]*			
	20 – 100 °C	*20 – 1200 °C*	*20 – 1300 °C*	*20 – 1400 °C*
21	10.2	11.3	11.9	12.8

heat capacity (20 °C) [$J \cdot kg^{-1} \cdot K^{-1}$]	*density (20 °C) [$kg \cdot dm^{-3}$]*
460	7,75

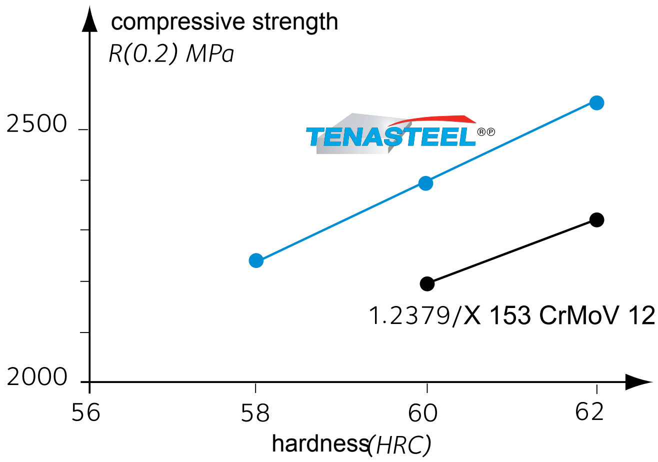
Abrasion resistance

The abrasion resistance of TENASTEEL®℗ is close to that of steel 1.2379 / X 153 CrMoV 12, with lower levels of carbon and chromium compensated by the addition of alloying elements that form finer and harder carbides than chromium carbides.

Note: Abrasion resistance is only considered for uncoated tools. If a coating (PVD/CVD) is present that counters abrasion, the toughness and compressive strength of the base material are taken into account.



Compressive strength



metallurgical properties

inclusion purity

The inclusion purity of TENASTEEL®℗ steel is guaranteed according to NFA 04-106 Method A.

value	A	B	C	D
index	≤ 1.5	≤ 1.5	≤ 1	≤ 1.5

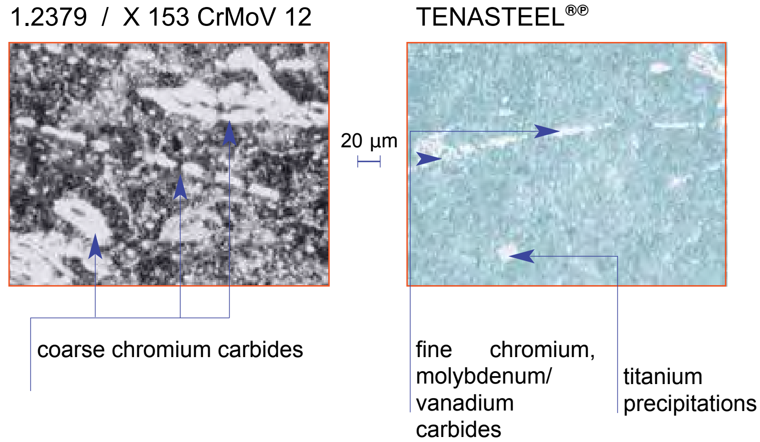
TENASTEEL

Microstructure

In its as-delivered state, the microstructure of TENASTEEL®℗ consists of a ferritic matrix. Small primary carbides, which form from the alloy's solidification, as well as very fine secondary carbides, resulting from annealing, are homogeneously distributed within this matrix.

The microphotographs below perfectly illustrate the overall refinement achieved with TENASTEEL®℗ in comparison to 1.2379 / X 153 CrMoV.

1.2379 / X 153 CrMoV 12 TENASTEEL®℗



TENASTEEL

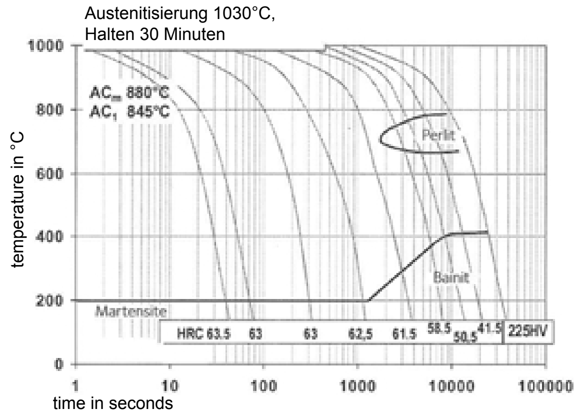
This difference in microstructure results in a significant improvement in toughness and machinability, while the wear resistance is maintained at a good level thanks to the presence of carbides that are harder than those typically found in 1.2379 / X 153 CrMoV 12.

Transformation Points

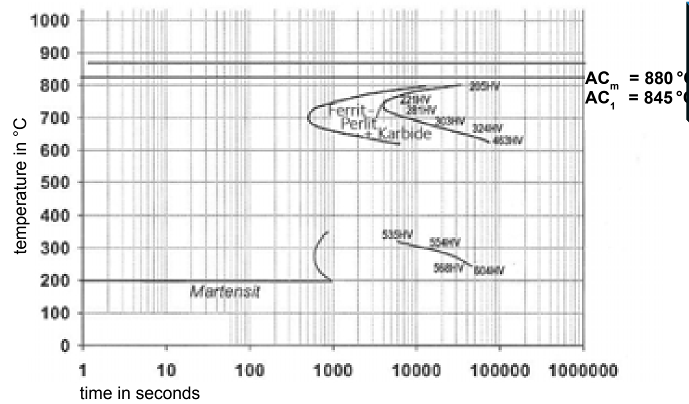
Test Conditions: Heating at a rate of 150°C per hour up to 1,000°C followed by rapid cooling.

AC_1 °C	AC_m °C	M_s °C
845	880	200

CCT-continuous cooling transformation diagramm



isothermal CCT diagram



Heat treatment

Austenitizing

Heating at a moderate rate up to 750°C and holding for equilibrium.
Slowly heating up to 1,030/1,050°C, holding for ½ hour per 25 mm.

Note:

The heating cycle must be conducted under vacuum or protective gas to prevent oxidation and decarburization of the surface.

Hardening

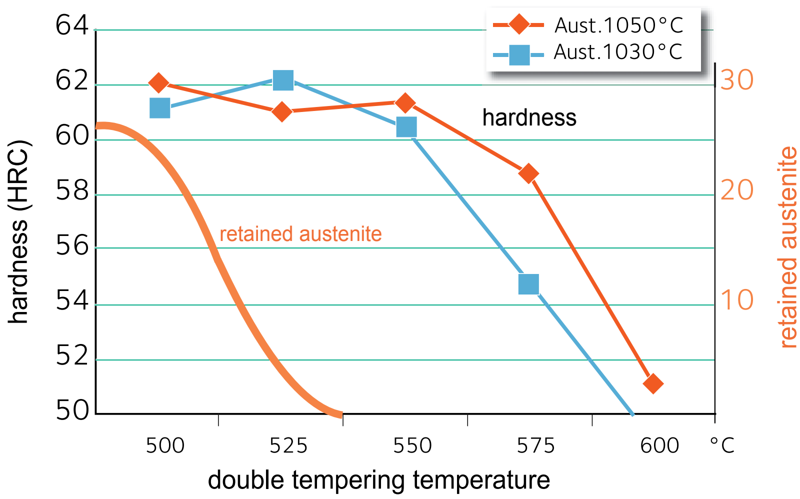
Cooling after austenitizing is preferably done under gas pressure, otherwise in a salt bath or a fluidized bed at temperatures between 250 and 350°C.

Oil quenching should be reserved for tools with simple geometry when the other mentioned methods are not sufficient to ensure an adequate cooling rate (see CCT diagrams).

Tempering must be carried out as soon as the tool temperature reaches 40 to 60°C, except in the case of deep freezing treatment (see "Deep Freezing Treatment" section, page 176).

Tempering

Depending on the application, the desired final hardness is achieved by adjusting the tempering temperatures, which are carried out for the target hardness with the tempering curves presented below.
After the first tempering, a nearly identical second tempering is performed at a slightly lower temperature to achieve a fully tempered final structure and ensure dimensional stability of the treated part.



The graph illustrates that a high austenitizing temperature (1,050°C) still results in a hardness of 58 HRC after tempering at 575°C.

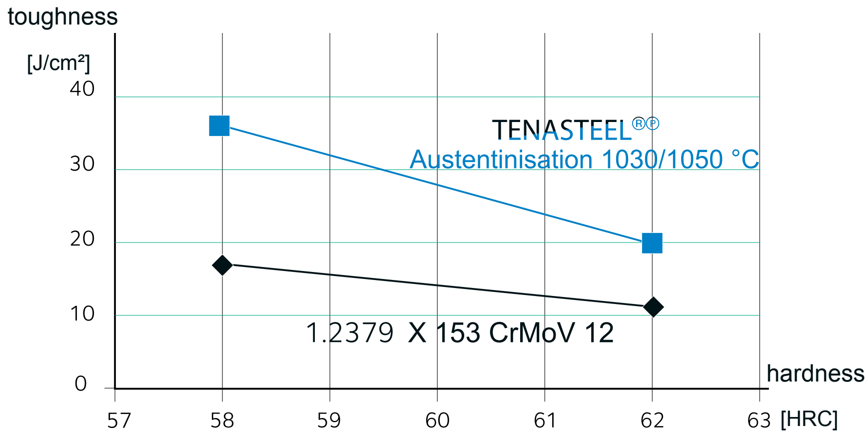
TENASTEEL®℗ allows for high tempering temperatures. After tempering at high temperatures (e.g., 550°C), the residual austenite content is very low. Parts treated in this way exhibit excellent dimensional stability during use.

Conversely, parts tempered below 500°C (with 20% residual austenite) may still experience dimensional changes after treatment.

The desired hardness level during heat treatment strongly affects toughness. Depending on usage conditions (pressure, impacts, mechanical properties of the formed steel), as well as any planned surface treatment and coating of the tool, it is possible to find the best compromise between wear resistance and toughness through hardness and tempering temperature adjustments.

The following diagram can assist in the selection process. In any case, TENASTEEL®℗ offers a better compromise between hardness and toughness than 1.2379 / X 153 CrMoV 12.

If you have any doubts, please don't hesitate to contact us. We are here to provide guidance.

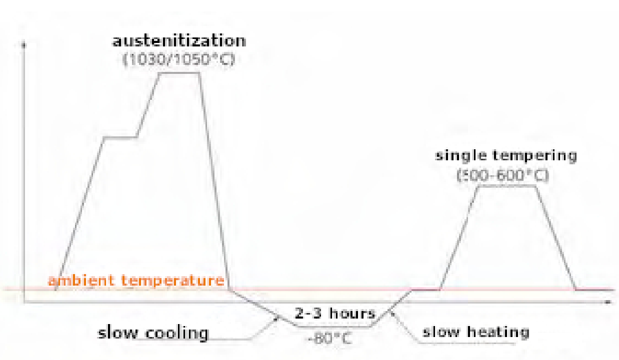


tempering temperature (°C)(Aust. 1030 °C)	560	555	550	540	525	°C
tempering temperature (°C)(Aust. 1050 °C)	580	575	565	550	525	°C

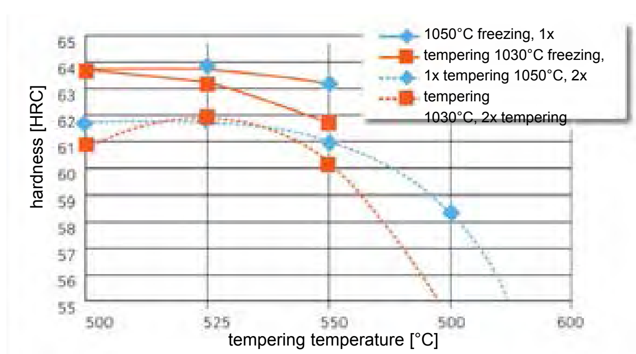
deep freezing treatment

The residual austenite remaining in the steel after hardening is safely reduced to nearly zero through cdeep freezing treatment. Dimensional changes due to subsequent transformations of residual austenite are thus avoided. If necessary, the deep freezing treatment can be performed as follows:

cryogenic treatment cycle



tempering curve after cryogenic treatment



Surface Coating

Coatings on tools, like surface hardening, serve to provide high wear resistance and a noticeable reduction in friction coefficients.
These processes differ from the previous ones in that an exogenous material layer is applied, which does not react with the base material and behaves like an additional "skin."

PVD: Physical Vapor Deposition

These types of deposits can occur at relatively low temperatures (200 to 500°C) and do not affect the hardness of the substrate. The achieved hardness levels can reach up to 2,000 HV over a few micrometers.Please note that for PVD coating applied after hardening, tempering at temperatures above 500°C is required.

CVD: Chemical Vapor Deposition

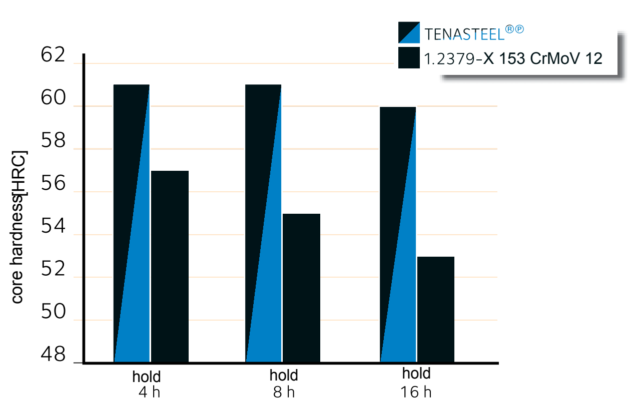
The temperature required to activate the reactions in CVD treatment is so high (800 to 1,000°C) that a subsequent heat treatment is necessary to adjust the hardness of the part after coating. The hardness of the coatings can reach and even exceed 2,500 HV.

Nitriding

The nitriding treatment is aimed at increasing surface hardness and wear resistance while reducing friction coefficients by enriching one or more elements in the surface layer of the part.

TENASTEEL®℗ is very well suited for nitriding thanks to its high hardness and excellent temper resistance.

Conventional gas and plasma nitriding at temperatures in the range of 500°C to 525°C allows the achievement of a hard layer on the order of over 1,100 HV with a thickness of several micrometers.

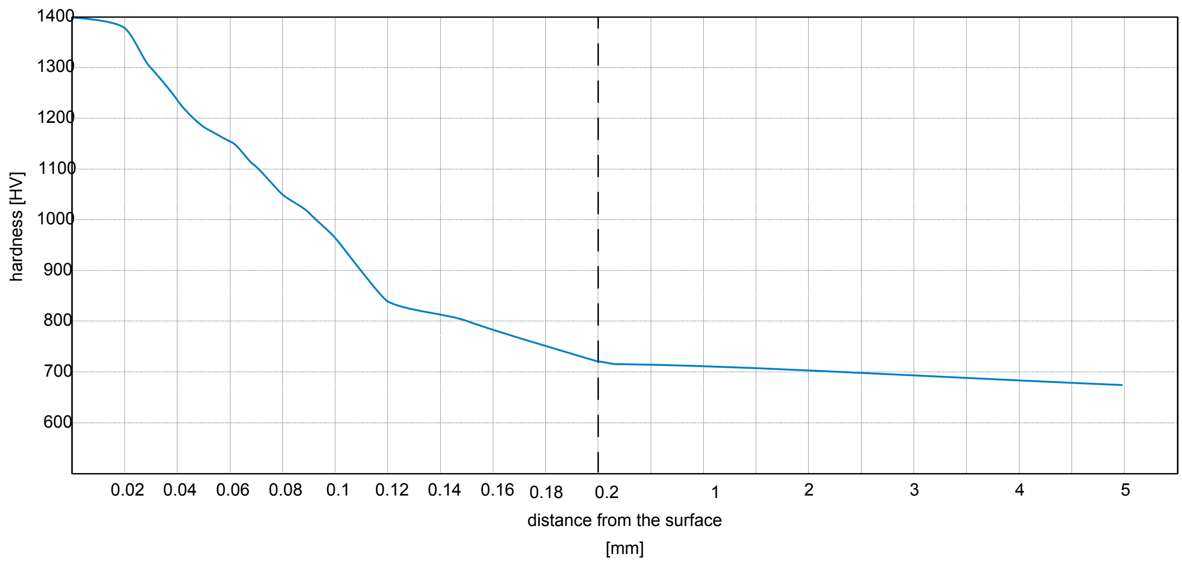


Please note that for nitriding treatment following hardening, it must be tempered at a minimum of 525°C.

The graph shown illustrates that the core hardness of TENASTEEL®℗ is not affected by the nitriding treatment, while 1.2379 / X 153 CrMoV 12 experiences a decrease in hardness of 5 to 10 HRC under the nitrided layer.

Nitriding

The hardness profile for gas nitriding at 16 hours



Processing – in the annealed state

Milling with coated carbide tools

Cutting parameters	*Schruppen*	*Schlichten*
Cutting speed (v_c) – m/Min	130 – 190	170 – 210
Feed rate (F_z) – mm/tooth	0.15 – 0.4	0.1 – 0.2
Cutting depth. (a_p) – mm	2 – 5	≤ 1.5

Drilling with HSS (High-Speed Steel) tools.

Cutting parameters	*ø ≤ 10*	*ø 10 – 20*
Cutting speed (v_c) – m/Min	15	15
Feed rate. (F_z) – mm/turn	0.05 – 0.2	0.2 – 0.3

Compared to 1.2379 / X 153 CrMoV 12, the fine carbide structure of TENASTEEL ensures a tool lifespan increase of at least 25% for machining in annealed condition and at least 70% for machining in hardened condition.

Electrical Discharge Machining (EDM) - Spark Erosion

TENASTEEL®℗ is suitable for all EDM processes before and after heat treatment. When EDM is performed in the hardened state, it should be finished immediately, and the EDM surfaces should be polished or stress-relieved (20°C below the last tempering temperature).

Welding

Repairing or welding tools made of TENASTEEL®℗ can be considered with some essential precautions when using appropriate welding materials. For further information, we can provide you with the TENASTEEL®℗ Handbook, which can also be found at **www.stahlnetz.de/downloads**.

Application

TENASTEEL® steel is advantageous in replacing standardized steel 1.2379 / X 153 CrMoV 12 in all of its applications: cutting tools, extrusion dies, forming tools, embossing tools, machine knives, and more.

Available products

Raw materials
Rolled sheets and blanks in thicknesses from 9 to 150 mm

VarioPlan®
Six-sided precision-machined semi-finished products, individually configurable on the webshop: www.varioplan.de

EroBlock®
EDM blocks, vacuum-hardened for the best toughness and tool life

PräziPlan®
Precision flat steel according to DIN 59350 - Special dimensions

Workpieces according to your drawings

Note:
All information is approximate and should not be construed as a guarantee of performance. If you have specific application questions, we are happy to provide guidance and advice!