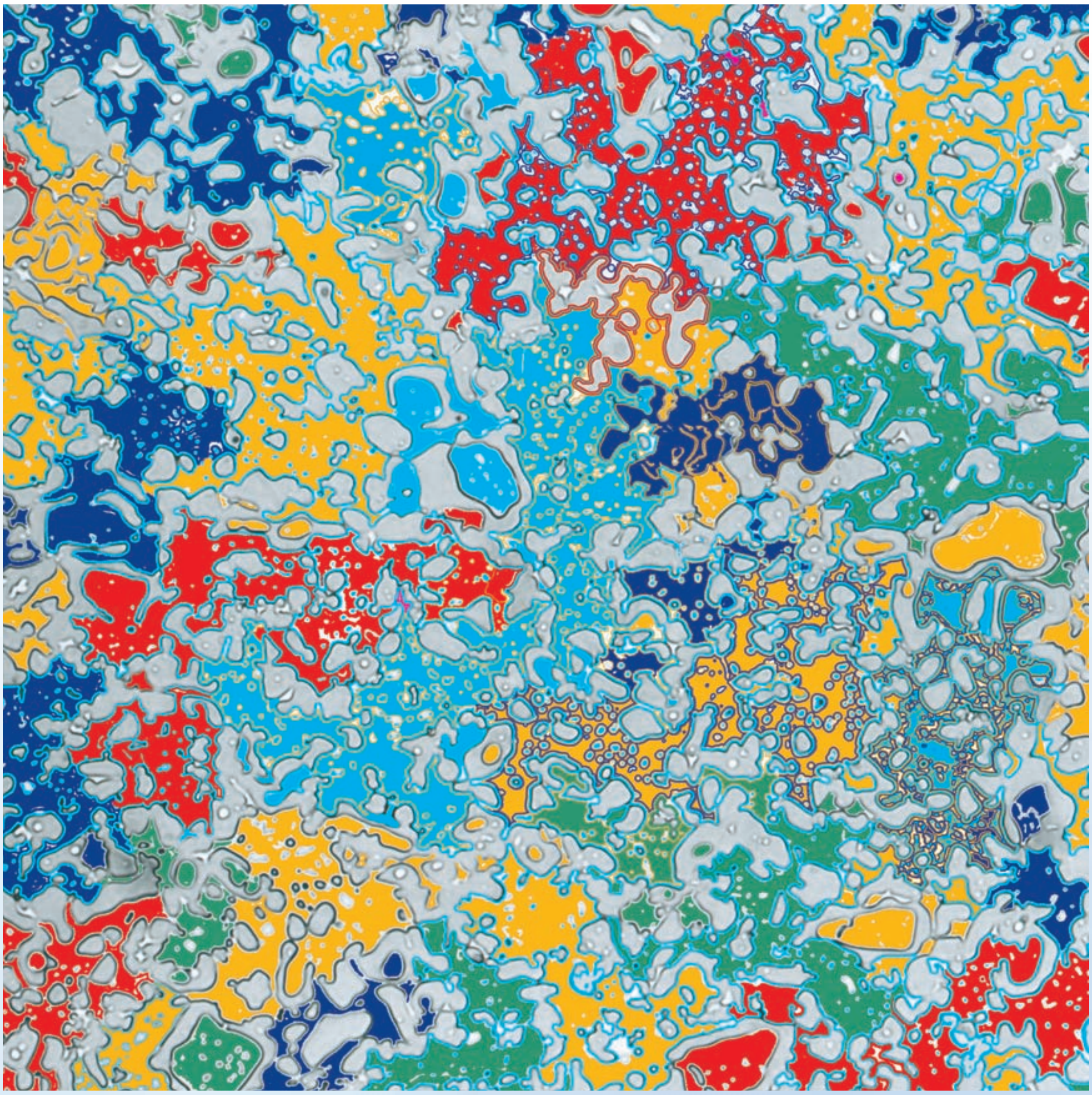
DEUTSCHE EDELSTAHLWERKE

Providing special steel solutions

*Powder-metallurgical carbide-alloyed materials*

# Ferro-Titanit®

## Hard Materials from Krefeld



# A hard act to follow – Ferro

Cutting

Punching

Stamping

Forming

Plastics processing

Wearing parts ...

*Grinding wheel spindle*

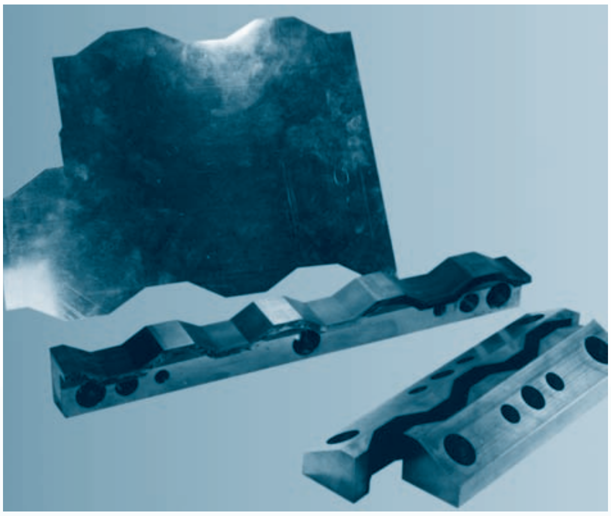
*Tube extrusion punches*

*Sizing punches*

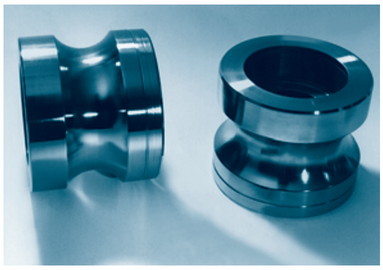
FERRO-T

**Powder-metallurgical carbide-alloyed materials**

# -Titanit®



*Scrolling knives*



*Straightening and guide rollers*

*Rolling-in tools*

*Lock-seaming rolls*

**Contents**



TITANIT®

# Ferro-Titanit®

## highly wear-resistant, light, machinable, hardenable

Ferro-Titanit is the trademark used by Edelstahl Witten-Krefeld GmbH (WK) for ultrahigh-alloyed, machinable and hardenable alloys made by powder metallurgy techniques.
The materials combine the properties of steel and tungsten-carbide alloys and are highly wear-resistant.
Ferro-Titanit has a titanium carbide content of around 45% by volume, embedded in an alloyed steel binder phase.
In as-delivered condition, this material can be machined by conventional methods.

In heat-treated, hardened condition (up to 69 HRC), Ferro-Titanit can be used to economically solve many wear problems.

FERRO-TITANIT®

| | | |
|---|---|---|
| Ferro-Titanit is hardenable up to 69 HRC. | A simple heat treatment brings about a considerably higher hardness than for steel. | The tools have exceptionally long service lives. Appreciable savings are achieved as a result of lower tool costs. Tool changeover costs are reduced through longer machine operating times. |
| Ferro-Titanit can be hardened with extremely little distortion, since titanium carbide has a low thermal expansion and no transformation. The microstructure is free from segregations and fibering due to the powder metallurgy process. | Vacuum hardening is advisable, as otherwise the negative influence zones on the tools require a greater machining allowance. | In the case of C-Spezial, hardening and tempering cause an increase in the original dimensions. WFN and S grades are shrink in dimensions due to retained austenite. Deep cooling in liquid nitrogen, on the other hand, increases the dimensions of these grades. The dimensional change is in each case less than 0.1%. |
| Ferro-Titanit offers good possible combinations with steel. | Joining by composite sintering, high-temperature brazing. | When used in combination, Ferro-Titanit is applied only in areas exposed to wear. The steel, as the substrate, permits material savings, offers higher toughness, and can be machined more cost-effectively. |
| Ferro-Titanit allows reutilisation of used tools. | Used tools and wearing parts can be annealed as often as required and processed into new parts (no change in the microstructure). | Minimum remachining in the soft-annealed condition permits swift replacement of failed tool or wearing components (example: remachining of a drawing tool to produce a larger profile). |
| Ferro-Titanit is machinable according to given guidelines (foldout page in this brochure). | It can be machined in the annealed as-delivered condition by conventional methods, such as turning, planing, milling, drilling, and other means. | Company-own tool shops can be employed, producing long-life tools at a relatively low total cost. |
| Ferro-Titanit exhibits minimum pick-up. | The titanium carbides in Ferro-Titanit (45% by vol.) do not alloy with other materials. | The hardly detectable pick-up with well-polished tools and dies - especially deep-drawing tools - and the high wear resistance lead to high outputs between remachinings, combined with a best-quality surface finish. |
| Ferro-Titanit has a low specific weight. | Ferro-Titanit is 50% lighter than tungsten carbide and still 15% lighter than steel. | Design advantages are derived in applications featuring high centrifugal forces. |

# Ferro-Titanit C-Spezial

## Chemical composition

| Carbide phase | Binder phase (main components) | | | |
|---|---|---|---|---|
| TiC | C | Cr | Mo | Fe |
| 33 | 0.65 | 3.0 | 3.0 | Balance |

*(guideline values in % by weight)*

## Microstructure

Titanium carbide + martensite

## Characteristic properties

The binder phase consists of a cold work steel containing 3% chromium and 3% molybdenum.
The relatively low alloy content brings about a low tempering resistance. The hardness decreases above approximately 200 °C. In comparison with the other grades, C-Spezial has the best machining properties.

## Mechanical properties

*hardened + tempered*

| Density | Compression strength | Bending fracture | Modulus of elasticity | Shear modulus | Service hardness |
|---|---|---|---|---|---|
| $g/cm^3$ | $N/mm^2$ | $N/mm^2$ | $N/mm^2$ | $N/mm^2$ | HRC |
| 6.5 | 3800 | 1500 | 292 000 | 117 000 | approx. 69 |

**Further data on the mechanical properties upon request**

## Physical properties

Thermal expansion coefficient between 20 and ... °C in $10^{-6} \cdot °C^{-1}$

| 100 | 200 | 300 |
|---|---|---|
| 9.2 | 9.1 | 9.8 |

Thermal conductivity at 20 °C in $W \cdot cm^{-1} \cdot °C^{-1}$

| 0.205 |
|---|

| Measuring frequency (Hz) | Damping $Q^{-1}(10^{-5})$ |
|---|---|
| 2600 | 14 |
| 7000 | 22 |
| 22 000 | 16 |

Electrical resistivity at 20 °C in $\Omega \cdot mm^2 \cdot m^{-1}$

| 0.75 |
|---|

## Magnetic properties

| Magnetic saturation polarisation mT | Coercive field strength $kA \cdot m^{-1}$ | Remanence mT |
|---|---|---|
| 920 | 5.0 | 315 |

## Use

All cold work applications in cutting and forming engineering, e.g. for cutting and blanking tools, bending jaws, extrusion punches, deep-drawing dies, form and hobbing punches, clamping jaws, blanking sleeves, tools for the processing of steel, non-ferrous metals, aluminium, etc., as well as machine elements such as pulleys, rollers and guides exposed to heavy wear.

# Ferro-Titanit C-Spezial

## Annealing

| Annealing temperature °C | Cooling | Hardness after annealing HRC | Transformation range °C |
|---|---|---|---|
| Soft 750 (10 h) | Furnace | approx. 49 | 800 – 852 |

## Stress-relieving

If extensive machining is required, it is advisable, after rough-machining, i.e. before finish-machining, to stress-relief anneal at around 600 – 650 °C, followed by cooling in the furnace.

## Hardening

| Hardening temperature °C | Hardening medium | Quenching |
|---|---|---|
| 980 – 1100 | Vacuum | 1 bar $N_2$ |

Heating to hardening temperature is advisably performed over several preheating stages (e.g. 400 °C, 600 °C, 800 °C) in order to ensure uniform soaking of the parts that are to be hardened and to avoid any cracking induced by thermal stress. The selected soaking time at hardening temperature must be longer than for steel tools (roughly twice to three times). Because of the rigid titanium carbide skeleton, deleterious grain growth as found in tool steel and high-speed steel cannot occur during the heat treatment. It is hence possible to accept slightly higher hardening temperatures and longer soaking times rather than insufficient hardening.

## Tempering

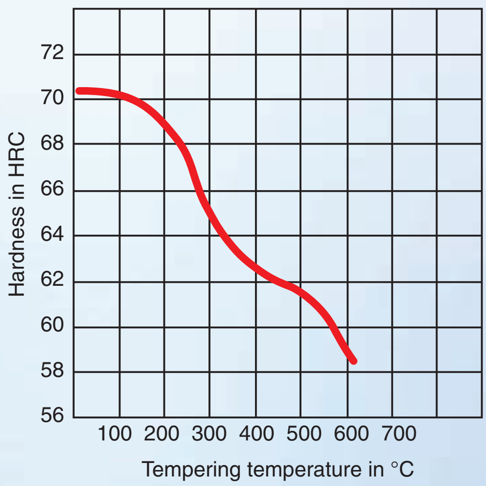
| Tempering temperature °C | Service hardness HRC |
|---|---|
| 150 | approx. 69 |

In order to avoid cracking induced by hardening stresses, parts that have been hardened must be tempered immediately after quenching or cooling to around 50 °C and held at tempering temperature for at least 2 hours, followed by cooling in air.

## Dimensional changes

Due to the hardening and tempering of C-Spezial, the original dimensions increase. The change in dimensions is less than 0.1%.

## Tempering curve




**Note:**
No tempering temperature other than the one indicated should be selected, as the strong, negative influence on the resistance to wear and pick-up does not justify the minor benefit of toughness improvement.

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# Ferro-Titanit WFN

## Chemical composition

| Carbide phase | Binder phase (main components) | | | |
|---|---|---|---|---|
| TiC | C | Cr | Mo | Fe |
| 33.0 | 0.75 | 13.5 | 3.0 | Balance |

*(guideline values in % by weight)*

## Microstructure

Titanium carbide + martensite

## Characteristic properties

Because of its 13.5% chromium and 3% molybdenum content, WFN has a high tempering resistance up to around 450 °C, as well as high-temperature hardness and good corrosion resistance. The thermal expansion coefficient is adjusted to that of steel through the 1% aluminium alloy addition. Lower stresses thereby occur when non-permanent and permanent joints are heated, reducing the risk of cracking

## Mechanical properties

*hardened + tempered*

| Density g/cm³ | Compression strength N/mm² | Bending fracture N/mm² | Modulus of elasticity N/mm² | Shear modulus N/mm² | Service hardness HRC |
|---|---|---|---|---|---|
| 6.5 | 3600 | 1200 | 294 000 | 122 000 | approx. 69 |

**Further data on the mechanical properties upon request**

## Physical properties

**Thermal expansion coefficient between 20 and … °C in $10^{-6} \cdot °C^{-1}$**

| 100 | 200 | 300 | 400 | 500 | 600 |
|---|---|---|---|---|---|
| 10.6 | 11.6 | 12.2 | 12.4 | 12.7 | 12.9 |

**Thermal conductivity at 20 °C in $W \cdot cm^{-1} \cdot °C^{-1}$**

0.182

| Measuring frequency (Hz) | Damping $Q^{-1}(10^{-5})$ |
|---|---|
| 2600 | 27 |
| 7100 | 33 |
| 22 000 | 27 |

**Electrical resistivity at 20 °C in $\Omega \cdot mm^2 \cdot m^{-1}$**

0.91

## Magnetic properties

| Magnetic saturation polarisation mT | Coercive field strength $kA \cdot m^{-1}$ | Remanence mT |
|---|---|---|
| 590 | 9.2 | 160 |

## Use

All cold work applications in cutting and forming engineering. In particular for tools and wearing parts required to have a high tempering resistance up to 450 °C as well as elevated corrosion resistance, e.g. guide rollers for wire rod and bar steel rolling, injection moulds for plastics processing, jets for steam-jet equipment, valve components, tube drawing dies, extrusion dies for the manufacture of aerosol cans, cold rollers.

# Ferro-Titanit WFN

## Annealing

| Annealing temperature °C | Cooling | Hardness after annealing HRC | Transformation range °C |
|---|---|---|---|
| Soft 750 (10 h) | Furnace | approx. 51 | 890 – 970 |

## Stress-relieving

If extensive machining is required, it is advisable, after rough-machining, i.e. before finish-machining, to stress-relief anneal at around 600 – 650 °C, followed by cooling in the furnace.

## Hardening

| Hardening temperature °C | Hardening medium | Quenching |
|---|---|---|
| 1080 | Vacuum | 1 bar $N_2$ |

Heating to hardening temperature is advisably performed over several preheating stages (e.g. 400 °C, 600 °C, 800 °C) in order to ensure uniform soaking of the parts that are to be hardened and to avoid any cracking induced by thermal stress. The selected soaking time at hardening temperature must be longer than for steel tools (roughly twice to three times). Because of the rigid titanium carbide skeleton, deleterious grain growth as found in tool steel and high-speed steel cannot occur during the heat treatment. It is hence possible to accept slightly higher hardening temperatures and longer soaking times rather than insufficient hardening.

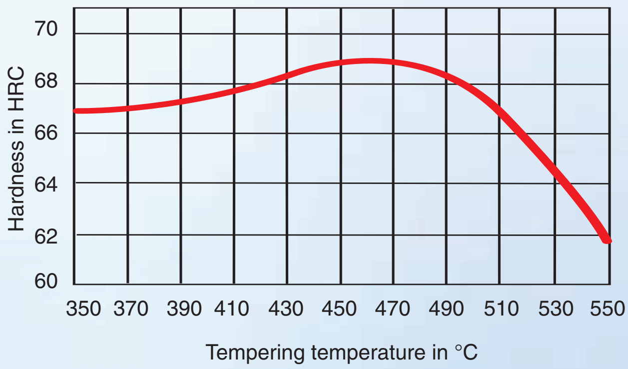
## Tempering

| Tempering temperature °C | Service hardness HRC |
|---|---|
| 460 | approx. 69 |

In order to avoid cracking induced by hardening stresses, parts that have been hardened must be tempered immediately after quenching or cooling to around 50 °C and held at tempering temperature for at least 2 hours, followed by cooling in air.

## Dimensional changes

The WFN grade exhibits a reduction in dimensions due to retained austenite. The dimensions are increased in this grade, however, by deep-cooling in liquid nitrogen or also repeated tempering. The change in dimensions is less than 0.1% in each case.




**Note:**
No tempering temperature other than the one indicated should be selected, as the strong, negative influence on the resistance to wear and pick-up does not justify the minor benefit of toughness improvement.

# Ferro-Titanit S

***Chemical composition***

| Carbide phase | Binder phase (main components) | | | |
|---|---|---|---|---|
| TiC | C | Cr | Mo | Fe |
| 32.0 | 0.5 | 19.5 | 2.0 | Balance |

*(guideline values in % by weight)*

***Microstructure***

Titanium carbide + martensite

***Characteristic properties***

Because of its high chromium and reduced carbon content, this grade is recommended in cases requiring elevated corrosion resistance.

***Mechanical properties***

*hardened + tempered*

| Density | Compression strength | Bending fracture | Modulus of elasticity | Shear modulus | Service hardness |
|---|---|---|---|---|---|
| $g/cm^3$ | $N/mm^2$ | $N/mm^2$ | $N/mm^2$ | $N/mm^2$ | HRC |
| 6.5 | 3700 | 1050 | 290 000 | 116 000 | approx. 67 |

**Further data on the mechanical properties upon request**

***Physical properties***

**Thermal expansion coefficient between 20 and 400 °C in $10^{-6} \cdot °C^{-1}$**

| | |
|---|---|
| 9.7 | |

**Thermal conductivity at 20 °C in $W \cdot cm^{-1} \cdot °C^{-1}$**

| | |
|---|---|
| 0.188 | |

| Measuring frequency (Hz) | Damping $Q^{-1}(10^{-5})$ |
|---|---|
| 2600 | 19 |
| 7100 | 25 |
| 22 300 | 18 |

**Electrical resistivity at 20 °C in $\Omega \cdot mm^2 \cdot m^{-1}$**

| | |
|---|---|
| 0.77 | |

***Magnetic properties***

| Magnetic saturation polarisation mT | Coercive field strength $kA \cdot m^{-1}$ | Remanence mT |
|---|---|---|
| 620 | 9.8 | 108 |

***Use***

For parts requiring a high resistance to corrosion as well as to wear, e.g. pumps, measuring tools, thrust disks, bearings, etc.

# Ferro-Titanit S

## Annealing

| Annealing temperature °C | Cooling | Hardness after annealing HRC | Transformation range °C |
|---|---|---|---|
| Soft 750 (10 h) | Furnace | approx. 51 | 800 – 850 |

## Stress-relieving

If extensive machining is required, it is advisable, after rough-machining, i.e. before finish-machining, to stress-relief anneal at around 600 – 650 °C, followed by cooling in the furnace.

## Hardening

| Hardening temperature °C | Hardening medium | Quenching |
|---|---|---|
| 1080 | Vacuum | 1 bar $N_2$ |

Heating to hardening temperature is advisably performed over several preheating stages (e.g. 400 °C, 600 °C, 800 °C) in order to ensure uniform soaking of the parts that are to be hardened and to avoid any cracking induced by thermal stress. The selected soaking time at hardening temperature must be longer than for steel tools (roughly twice to three times). Because of the rigid titanium carbide skeleton, deleterious grain growth as found in tool steel and high-speed steel cannot occur during the heat treatment. It is hence possible to accept slightly higher hardening temperatures and longer soaking times rather than insufficient hardening.

## Tempering

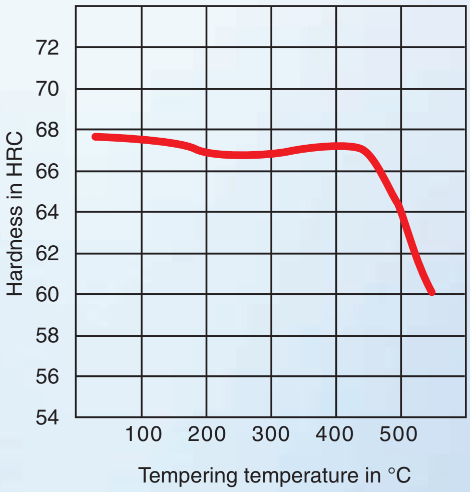
| Tempering temperature °C | Service hardness HRC |
|---|---|
| 180 | approx. 67 |

In order to avoid cracking induced by hardening stresses, parts that have been hardened must be tempered immediately after quenching or cooling to around 50 °C and held at tempering temperature for at least 2 hours, followed by cooling in air.

## Dimensional changes

The S grade exhibits a reduction in dimensions due to retained austenite. The dimensions are increased in this grade, however, by deep-cooling in liquid nitrogen or also repeated tempering. The change in dimensions is less than 0.1% in each case.

## Tempering curve




**Note:**
No tempering temperature other than the one indicated should be selected, as the strong, negative influence on the resistance to wear and pick-up does not justify the minor benefit of toughness improvement.

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# Ferro-Titanit Nikro 128

## *Chemical composition*

| Carbide phase | Binder phase (main components) | | | | |
|---|---|---|---|---|---|
| TiC | Cr | Co | Ni | Mo | Fe |
| 30 | 13.5 | 9 | 4 | 5 | Balance |

*(guideline values in % by weight)*

## *Microstructure*

Titanium carbide + nickel martensite

## *Characteristic properties*

The matrix structure consists of a highly tough, age-hardenable nickel martensite. The chromium content of 13.5% provides good corrosion resistance. Finish-machining is performed in the solution-annealed, as-delivered condition. Subsequent age-hardening takes place at a relatively low temperature of 480 °C and can be conducted, for example, in a convection air furnace or an electrically heated chamber furnace. The workpiece remains extremely true-to-size and little prone to distortion due to the low age-hardening temperature.

## *Mechanical properties*

*age-hardened*

| Density g/cm³ | Compression strength N/mm² | Bending fracture N/mm² | Modulus of elasticity N/mm² | Shear modulus N/mm² | Service hardness HRC |
|---|---|---|---|---|---|
| 6.6 | 2750 | 1200 | 294 000 | 117 000 | approx. 62 |

**Further data on the mechanical properties upon request**

## *Physical properties*

Thermal expansion coefficient between 20 and … °C in $10^{-6} \cdot °C^{-1}$

| 100 | 200 | 300 | 400 | 500 | 600 | 700 | 800 |
|---|---|---|---|---|---|---|---|
| 8.3 | 8.9 | 9.3 | 9.6 | 9.9 | 10.2 | 9.2 | 9.5 |

Thermal conductivity at … °C in $W \cdot cm^{-1} \cdot °C^{-1}$

| 100 | 150 | 200 | 250 | 300 | 350 | 400 | 450 | 500 | 550 | 600 |
|---|---|---|---|---|---|---|---|---|---|---|
| 0.171 | 0.178 | 0.188 | 0.199 | 0.212 | 0.226 | 0.242 | 0.259 | 0.276 | 0.295 | 0.315 |

| Measuring frequency (Hz) | Damping $Q^{-1}(10^{-5})$ |
|---|---|
| 2600 | 10.0 |
| 7100 | 15.2 |
| 14 000 | 11.9 |
| 22 000 | 10.9 |

Electrical resistivity at 20 °C in $\Omega \cdot mm^2 \cdot m^{-1}$

| 20 | 100 | 200 | 300 | 400 | 500 | 600 |
|---|---|---|---|---|---|---|
| 1.10 | 1.12 | 1.17 | 1.21 | 1.25 | 1.31 | 1.67 |

## *Magnetic properties*

*magnetically clampable*

| Magnetic saturation polarisation mT | Coercive field strength $kA \cdot m^{-1}$ | Remanence mT |
|---|---|---|
| 740 | 3.7 | 190 |

## *Use*

Good possibilities of use in the processing of abrasive plastics – as pelletizer knives, injection moulding nozzles, dies, worms and bushes. Also as wear-resistant rings in centrifugal pumps, charging heads and circular cutters in preserve-can filling machines.

# Ferro-Titanit Nikro 128

## *Solution annealing*

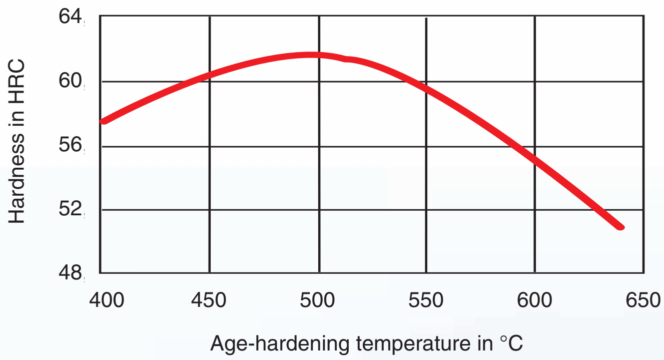
| Annealing temperature °C | Cooling | Hardness after annealing HRC |
|---|---|---|
| 850 (2 – 4 h vacuum) | 1 – 4.5 bar $N_2$ | approx. 53 |

The material is supplied in solution-annealed condition by the producer. Due to this fact, only ageing at 480 °C is still required after finish-machining.

## *Age-hardening*

| temperature °C | Hardness after age-hardening HRC |
|---|---|
| 480 (6 – 8 h) | approx. 62 |

## *Age-hardening curve*




**Note:**
Carburising atmospheres are to be avoided during heat treatment. Linear shrinkage during age-hardening is generally 0.02 mm/m.



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# Ferro-Titanit Nikro 143

## *Chemical composition*

| Carbide phase | Binder phase (main components) | | | |
|---|---|---|---|---|
| TiC | Ni | Co | Mo | Fe |
| 30 | 15.0 | 9.0 | 6.0 | Balance |

*(guideline values in % by weight)*

## *Microstructure*

**Titanium carbide + nickel martensite**

## *Characteristic properties*

The matrix structure consists of a highly tough, age-hardenable nickel martensite. Finishing is performed in the solution-annealed, as-delivered condition. Subsequent age-hardening takes place at a relatively low temperature of 480 °C and can be conducted, for example, in a convection air furnace or an electrically heated chamber furnace. The workpiece remains extremely true-to-size and little prone to distortion due to the low age-hardening temperature.

## *Mechanical properties*

*age-hardened*

| Density | Compression strength | Bending fracture | Modulus of elasticity | Shear modulus | Service hardness |
|---|---|---|---|---|---|
| $g/cm^3$ | $N/mm^2$ | $N/mm^2$ | $N/mm^2$ | $N/mm^2$ | HRC |
| 6.7 | 2400 | 1450 | 280 000 | 117 000 | approx. 63 |

**Further data on the mechanical properties upon request**

## *Physical properties*

**Thermal expansion coefficient between 20 and … °C in $10^{-6} \cdot °C^{-1}$**

| 100 | 200 | 300 | 400 | 500 | 600 | 700 | 800 | 900 | 1000 |
|---|---|---|---|---|---|---|---|---|---|
| 8.0 | 8.7 | 8.9 | 9.1 | 9.4 | 9.8 | 9.4 | 8.5 | 9.2 | 9.7 |

**Thermal conductivity at .. °C in $W \cdot cm^{-1} \cdot °C^{-1}$**

| 20 – 80 °C |
|---|
| 0.181 – 0.189 |

**Electrical resistivity at 20 °C in $\Omega \cdot mm^2 \cdot m^{-1}$**

| 0.806 |
|---|

## *Magnetic properties*

*magnetically clampable*

| Magnetic saturation polarisation mT | Coercive field strength $kA \cdot m^{-1}$ | Remanence mT |
|---|---|---|
| 1580 | 1.8 | 230 |

## *Use*

For all types of forming tools, etc. exposed to particularly heavy wear and bending at temperatures up to 500 °C. For wearing parts of machinery and apparatus. Used especially in plastics processing as pelletizer knives, extruder worms, injection moulding nozzles, etc.

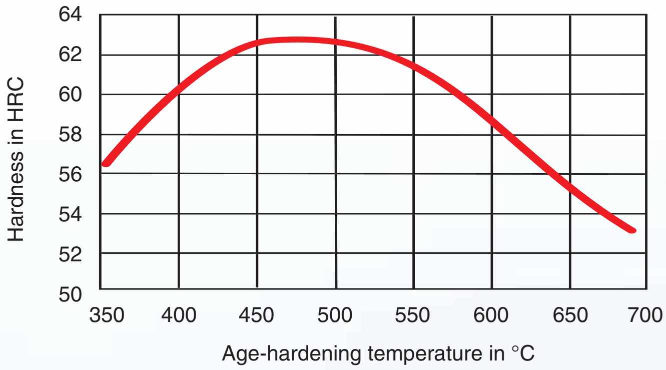
## *Solution annealing*

| Annealing temperature °C | Cooling | Hardness after annealing HRC |
|---|---|---|
| 850 (2 – 4 h vacuum) | 1 – 4.5 bar $N_2$ | approx. 53 |

## *Age-hardening*

| temperature °C | Hardness after age-hardening HRC |
|---|---|
| 480 (6 – 8 h) | approx. 63 |

## *Age-hardening curve*




**Note:**
Carburising atmospheres are to be avoided during heat treatment. Linear shrinkage during age-hardening is generally 0.02 mm/m.

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# Ferro-Titanit Cromoni

## *Chemical composition*

| Carbide phase | Binder phase (main components) | | |
|---|---|---|---|
| TiC | Cr | Mo | Ni |
| 22.0 | 20.0 | 15.5 | Balance |

*(guideline values % by weight)*

## *Microstructure*

**Titanium carbide + austenite**

## *Characteristic properties*

Supplied in solution-annealed condition. Ferro-Titanit Cromoni is non-magnetisable, even after ageing at temperatures up to 900 °C. Besides having a high wear resistance, this alloy is extremely resistant to corrosion and scaling, as well as highly tempering-resistant. This corrosion resistance is at its best with finely ground or polished surfaces.

## *Mechanical properties*

*age-hardened*

| Density | Compression strength | Bending fracture | Modulus of elasticity | Service hardness |
|---|---|---|---|---|
| g/cm³ | N/mm² | N/mm² | N/mm² | HRC |
| 7.4 | 1500 | 1300 | 277 000 | approx. 54 |

**Further data on the mechanical properties upon request**

## *Physical properties*

**Thermal expansion coefficient between 20 and … °C in $10^{-6} \cdot °C^{-1}$**

| 100 | 200 | 300 | 400 | 500 | 600 |
|---|---|---|---|---|---|
| 9.0 | 10.0 | 10.5 | 10.8 | 11.1 | 11.5 |

**Thermal conductivity at 20 °C in $W \cdot cm^{-1} \cdot °C^{-1}$**

| |
|---|
| 0.124 |

| **Measuring frequency (Hz)** | **Damping $Q^{-1}(10^{-5})$** |
|---|---|
| 2400 | 6 |
| 6600 | 7 |
| 21 000 | 11 |

**Electrical resistivity at 20 °C in $\Omega \cdot mm^2 \cdot m^{-1}$**

| |
|---|
| 1.53 |

## *Magnetic properties*

| **Permeability μ** |
|---|
| **< 1.01** |

## *Use*

This austenitic grade is used for applications requiring complete non-magnetisability, a high wear resistance and maximum corrosion resistance.

## Solution annealing

| Annealing temperature °C | Cooling | Hardness after annealing HRC |
|---|---|---|
| 1200 (2 h vacuum) | 4 bar $N_2$ | approx. 52 |

## Age-hardening

| temperature °C | Hardness after age-hardening HRC | |
|---|---|---|
| 800 (6 h vacuum) | approx. 54 | |

## Note

Machining according to guidelines, at lowest cutting speeds.


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# Ferro-Titanit U

## Chemical composition

| Carbide phase | Binder phase (main components) | | | |
|---|---|---|---|---|
| TiC | Cr | Ni | Mo | Fe |
| 34 | 18 | 12 | 2 | Balance |

*(guideline values in % by weight)*

## Microstructure

Titanium carbide + austenite

## Characteristic properties

The binder phase of Ferro-Titanit U is roughly equivalent to the austenitic CrNiMo steel X 10 CrNiMoNb 18 10 (Mat. No. 1.4580). The material is non-magnetisable and, because of its high Cr and Mo contents, possesses excellent resistance to pitting corrosion in media containing chlorine ions. Its high titanium carbide content of 34% by weight, or 45% by volume, provides it with outstanding wear resistance. The Cr and Ni contents simultaneously give the material good scaling resistance and high-temperature strength.
**The material requires no later postheat treatment.**

## Mechanical properties

*age-hardened*

| Density | Compression strength | Bending fracture | Service hardness |
|---|---|---|---|
| $g/cm^3$ | $N/mm^2$ | $N/mm^2$ | HRC |
| 6.6 | 2200 | 950 | approx. 51 |

**Further data on the mechanical properties upon request**

## Physical properties

Thermal expansion RT – 800 °C

| |
|---|
| 12.5 |

Thermal conductivity at 20 °C in $W \cdot cm^{-1} \cdot °C^{-1}$

| |
|---|
| 0.180 |

Electrical resistivity at 20 °C in $\Omega \cdot mm^2 \cdot m^{-1}$

| |
|---|
| 0.96 |

## Magnetic properties

| Permeability μ |
|---|
| < 1.01 |

## Use

Ferro-Titanit U is used where non-magnetisable material with a high wear resistance is required. Its excellent corrosion resistance, in particular in media containing chlorine ions, gives it a broad range of applications in the chemical industry.

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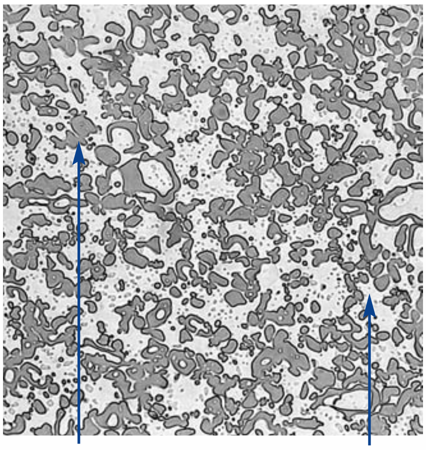
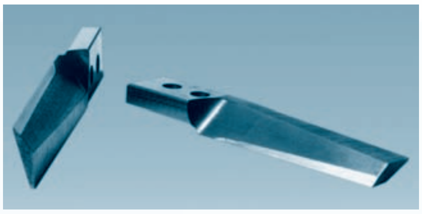
# A hard act to follow – Ferro

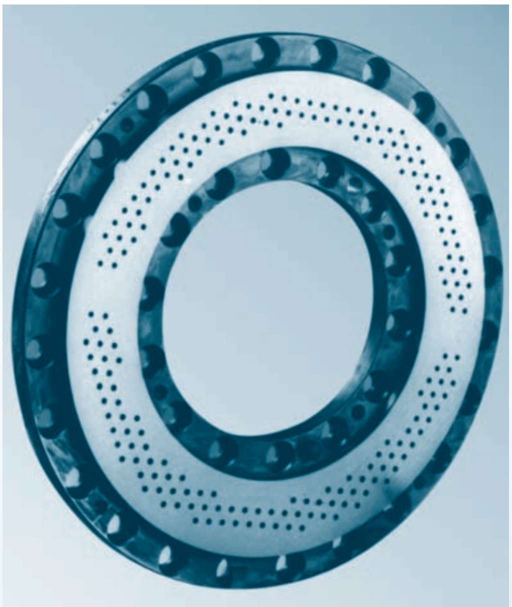


Titanium carbides (grey) Binder phase (white)

*Micrograph of a Ferro-Titanit grade; titanium carbides embedded in a steel matrix, scale approx. 1:1000. Cover motif colour-processed by computer.*



*Pelletizer knives*



*Pelletizer die*

*Pump plunger*

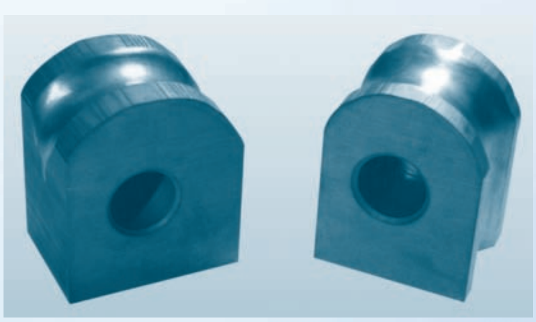
*Bending mandrels*

# -Titanit®

Valve cones and seats

Slide ring seals


Ultrasonic welding sonotrode



Bending tools

TITANIT®

# Machining of Ferro-Titanit

As a rule, the machinable and hardenable Ferro-Titanit alloys are supplied as semi-finished material in soft-annealed condition. Despite a titanium carbide content of around 45% by vol. and a hardness of 48 - 53 HRC after annealing, it is possible to machine these materials by conventional methods, such as turning, planing, milling, sawing and drilling, according to the guidelines given below.

Any tool shop therefore has the possibility to machine tools and other wear-exposed parts on equipment normally used for machining steels.

Ferro-Titanit can be hardened with very little distortion. There is, consequently, extremely little change in the dimensions. Where C-Spezial is concerned, hardening and tempering brings about an increase in the original dimensions. With the WFN and S grades, retained austenite leads to a reduction in the dimensions. Deep-cooling in liquid nitrogen makes it possible to increase the dimensons in these grades after hardening.

The dimensional changes are less than 0.1% in each case.

Machining in the annealed, as-delivered condition can consequently approximate the nominal size very closely, such that re-machining in hardened condition need amount to only a few hundredths of a millimetre. A precondition in this respect is that the hardening treatment to achieve the optimum service properties is performed preferably in a vacuum furnace. The machining of Ferro-Titanit can only be done with greatly reduced cutting speeds, compared with steel.

The machining techniques listed below must be applied dry:

## *Turning*

| Ferro-Titanit grades | tool quality alernatively | feed rate | cutting edge angle<br>rake angle | inclination angle | clearance angle | cutting speed m/min |
|---|---|---|---|---|---|---|
| C-Spezial | | | | | | 10 |
| WFN | | | | | | 8 |
| S | tungsten carbide coated, K 10 / K 30, high-speed steel | | | | | 8 |
| NIKRO 143 | | 0.02 – 0.1 mm/rev. | 6 ° / 15 ° | 0 ° / – 6 ° | 6 ° – 11 ° | 5 |
| NIKRO 128 | | | | | | 5 |
| U | | | | | | 5 |
| CROMONI | | 0.02 – 0.04 mm/rev. | | | | 2.5 |
| all grades | ceramics, fiber-reinforced | ~ 0.1 – 0.5 mm/rev. | – 6 ° | – 6 ° | + 6 ° | > 25 |

## *Milling*

| Ferro-Titanit grades | tool quality alernatively | feed rate | | cutting speed m/min |
|---|---|---|---|---|
| C-Spezial<br>WFN<br>S<br>NIKRO 143<br>NIKRO 128<br>U | tungsten carbide coated, K 10/ K 30, high-speed steel | 0.01 – 0.07 mm/tooth | | 6 – 12 |
| CROMONI | | ~ 0.01 mm/tooth | | 2 – 5 |

## *Drilling*

| Ferro-Titanit grades | tool quality alernatively | feed rate | | cutting speed m/min |
|---|---|---|---|---|
| all grades | tungsten carbide coated, K 10 / K 30, high-speed steel | 0.05 mm/U | rake angel 90 – 120 ° | 2 – 4 |

## *Thread cutting*

| Ferro-Titanit grades | tool quality alernatively | feed rate | rake angle | | cutting speed m/min |
|---|---|---|---|---|---|
| all grades | tungsten carbide high-speed steel | | 0 | cutting edge champfer 1.5 – 2 mm wide, extensive undercut | 2 – 4 |

## *Sawing**

** band saw (preferably)*
*hack saw (in exceptional cases)*

| Ferro-Titanit grades | tool quality alernatively | feed rate | constant "a" for calculation of feed rate | cutting speed m/min |
|---|---|---|---|---|
| C-Spezial<br>WFN | | | 800 mm²/min | |
| S<br>NIKRO 143<br>NIKRO 128<br>U | bimetall M 42 | constant "*a*" / length of saw notch | 600 mm²/min | ~ 10 |
| CROMONI | | | 200 mm²/min | < 5 |

| recommended partition of saw bands | length of saw notch | conventional toothing | combi toothing |
|---|---|---|---|
| | up to 30 mm | 10 teeth/inch | 8/12 teeth/inch |
| | 30 – 70 mm | 8 teeth/inch | 5/8 teeth/inch |
| | 7– 120 mm | 4 teeth/inch | 4/6 teeth/inch |
| | > 120 mm | 3 teeth/inch | 2/3 teeth/inch |

## Grinding

The high carbide content and the titanium carbide's high hardness make it self-evident that special attention must be paid when grinding. In this respect, it is of decisive importance whether the carbides are present in a soft-annealed or in a hardened steel binder phase. Grinding in hardened condition leads to significantly higher grinding wheel wear. Corundum wheels with a ceramic bond, porous structure and fine grain have proven a suitable medium. In case of special questions, the grinding wheel manufacturer should be consulted.

Diamond wheels made from plastic-bonded, nickel-coated synthetic diamonds with a concentration of 75 c - 100 c in a diamond grit size of D 107 - D 151 are recommended particularly for the finish-grinding of Ferro-Titanit in hardened condition.

Attention must be paid to the following basic rules when grinding:

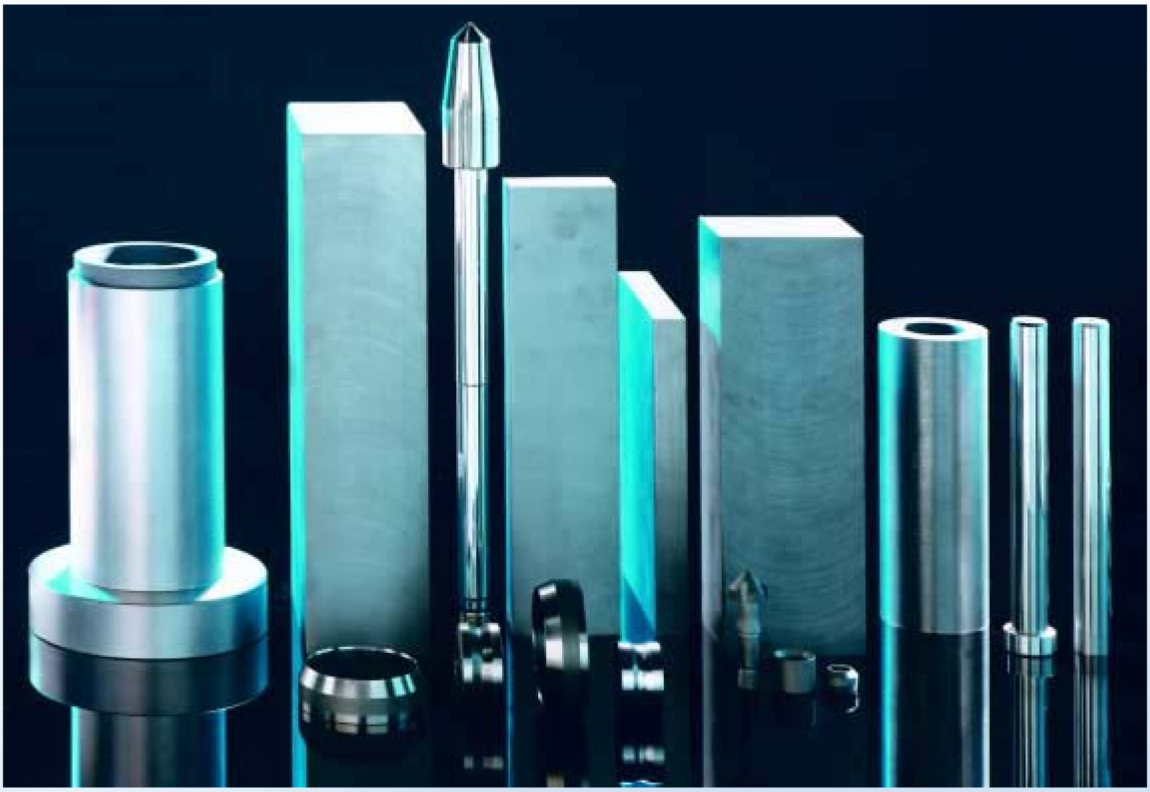
1. Grind with a powerful, rinsing stream of coolant directed as close as possible to the wheel/workpiece contact point.
2. Select the smallest possible in-feed rate.

## Polishing

The surface quality of the high-grade Ferro-Titanit carbide-alloyed materials is important for tool and machine part durability. Grinding to a best possible surface quality should generally be followed by polishing with a diamond polishing paste in order to achieve an ideal surface quality.
Rough-polishing is performed with diamond fine grit D 15 (10 - 25 µm), and finish-polishing with D 3 (2 - 5 µm).
If necessary, this may be followed by polishing with D 1 (1 - 2 µm).

## Spark-erosion machining

During spark erosion, Ferro-Titanit carbide alloys, tool steels and tungsten carbide alloys are subjected to the same influences. The overall behaviour when Ferro-Titanit is eroded tends to be similar to that of tool steels.
As spark erosion leads to generally strong, negative influences being exerted on tool surfaces, depending on the amperage applied, Ferro-Titanit should be finish-eroded with a low pulse energy.
Spark-erosion roughing should be followed by a finishing and a fine-finishing operation in order to achieve the lowest possible surface roughness and freedom from cracking. Re-machining is necessary after such erosion including, where possible, stress-relieving treatment to reduce the stresses that have come about during the sintering process.



**General note (liability)**

All statements regarding the properties or utilisation of the materials or products mentioned are for the purposes of description only. Guarantees regarding the existence of certain properties or a certain utilisation are only ever valid if agreed upon in writing.

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durability.

Longer
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