## Alloying elements

<table>
<thead>
<tr>
<th>Element</th>
<th>Melting point</th>
<th>Importance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aluminium (Al)</td>
<td>658 °C</td>
<td>This is the strongest and very frequently used deoxidation and denitriding compound which supports the steel during its ageing. Since Aluminium nitrides with Nitrogen to produce a very hard compound, it is usually used as an alloy in nitriding steel.</td>
</tr>
<tr>
<td>Carbon (C)</td>
<td>3450 °C</td>
<td>Carbon is the most important and indispensable steel alloying elements.</td>
</tr>
<tr>
<td>Cobalt (Co)</td>
<td>1492 °C</td>
<td>Cobalt is always used together with other alloying elements such as Chromium and Tungsten. It increases the hot hardness and wear resistance in high speed steel.</td>
</tr>
<tr>
<td>Chromium (Cr)</td>
<td>1920 °C</td>
<td>Chromium forms hard carbides, which increases the wear resistance and the durability of cutting edges. At the same time it facilitates through hardening.</td>
</tr>
<tr>
<td>Copper (Cu)</td>
<td>1084 °C</td>
<td>Copper is used as an alloying element for only a few steel grades because it accumulates below the scale and can penetrate the grain of the steel causing very fragile surfaces in hot forming processes. It is sometimes considered to have a damaging effect on steel.</td>
</tr>
<tr>
<td>Manganese (Mn)</td>
<td>1221 °C</td>
<td>Manganese binds Sulphur to Manganese Sulphides and thereby reduces the adverse effects of the Iron Sulphide. All steel grades contain small amounts of Manganese in order to facilitate casting, rolling and forging. It is considered an alloying element only if its content is greater than 0.5%.</td>
</tr>
<tr>
<td>Molybdenum (Mo)</td>
<td>2623 °C</td>
<td>Molybdenum is usually used together with other alloying elements. It works like Chromium but is stronger. In combination with Chromium it results in a higher hot hardness.</td>
</tr>
<tr>
<td>Nickel (Ni)</td>
<td>1453 °C</td>
<td>Nickel gives cold work steels a higher toughness. Engineering steels contain Nickel in combination with Chromium and Molybdenum in order to improve their strength.</td>
</tr>
<tr>
<td>Phosphor (P)</td>
<td>44 °C</td>
<td>This strong alloying element usually has a damaging effect on steel.</td>
</tr>
<tr>
<td>Sulphur (S)</td>
<td>118 °C</td>
<td>Sulphur has a low solubility in Iron but forms stable Sulphides with some other alloying elements. Manganese Sulphides are favourable because they have a positive effect on machining.</td>
</tr>
<tr>
<td>Silicon (Si)</td>
<td>1414 °C</td>
<td>This is included in all steel grades in order to facilitate the processing of the steel. It is considered an alloying element only if its content is greater than 0.5%.</td>
</tr>
<tr>
<td>Vanadium (V)</td>
<td>1726 °C</td>
<td>Vanadium is a good Carbide former. It binds Nitrogen and has a refining effect on the crystals. The result is a finer structure. The hard carbides increase the heat resistance, wear resistance and resistance to tempering.</td>
</tr>
<tr>
<td>Tungsten (W)</td>
<td>3380 °C</td>
<td>Tungsten forms hard carbides with very good cutting properties and also provides a high hot hardness. The tensile strength, yield strength, wear resistance and toughness can be increased with Tungsten.</td>
</tr>
<tr>
<td>Material no.</td>
<td>Designation</td>
<td>Indicatory analysis</td>
</tr>
<tr>
<td>-------------</td>
<td>-------------</td>
<td>--------------------</td>
</tr>
<tr>
<td>1.0577</td>
<td>DIN: A52 J2</td>
<td>C ≤ 0.22</td>
</tr>
<tr>
<td></td>
<td>AFNOR: A52 FP</td>
<td>Si ≤ 0.55</td>
</tr>
<tr>
<td></td>
<td>AISI: A738</td>
<td>Mn ≤ 1.60</td>
</tr>
<tr>
<td>1.1730</td>
<td>DIN: A45 U</td>
<td>C ≤ 0.45</td>
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<tr>
<td></td>
<td>AFNOR: XC 48</td>
<td>Si ≤ 0.30</td>
</tr>
<tr>
<td></td>
<td>AISI: 1045</td>
<td>Mn ≤ 0.70</td>
</tr>
<tr>
<td>1.2083</td>
<td>DIN: X40 Cr 14</td>
<td>C ≤ 0.40</td>
</tr>
<tr>
<td></td>
<td>AFNOR: Z 40 C 14</td>
<td>Si ≤ 0.40</td>
</tr>
<tr>
<td></td>
<td>AISI: 420</td>
<td>Mn ≤ 0.30</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Cr ≤ 1.30</td>
</tr>
<tr>
<td>1.2083 ESU (ESR)</td>
<td>DIN: X40 Cr 14</td>
<td>C ≤ 0.40</td>
</tr>
<tr>
<td></td>
<td>AFNOR: Z 40 C 14</td>
<td>Si ≤ 0.40</td>
</tr>
<tr>
<td></td>
<td>AISI: 420 ESR</td>
<td>Mn ≤ 0.30</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Cr ≤ 1.30</td>
</tr>
<tr>
<td>1.2085</td>
<td>DIN: X33 CrS 16</td>
<td>C ≤ 0.33</td>
</tr>
<tr>
<td></td>
<td>AFNOR: Z 35 CD 17.5</td>
<td>Si ≤ 0.33</td>
</tr>
<tr>
<td></td>
<td>AISI: ≈ 422 S</td>
<td>Mn ≤ 0.80</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Cr ≤ 1.60</td>
</tr>
<tr>
<td></td>
<td></td>
<td>S ≤ 0.06</td>
</tr>
<tr>
<td>1.2162</td>
<td>DIN: 21 MnCr 5</td>
<td>C ≤ 0.21</td>
</tr>
<tr>
<td></td>
<td>AFNOR: 20 MC 5</td>
<td>Si ≤ 0.25</td>
</tr>
<tr>
<td></td>
<td>AISI: 5120</td>
<td>Mn ≤ 1.25</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Cr ≤ 1.20</td>
</tr>
<tr>
<td>1.2210</td>
<td>DIN: 115 CrV 3</td>
<td>C ≤ 1.18</td>
</tr>
<tr>
<td></td>
<td>AFNOR: 100 C3</td>
<td>Si ≤ 0.25</td>
</tr>
<tr>
<td></td>
<td>UNI: 107 CrV 3 KU</td>
<td>Mn ≤ 0.30</td>
</tr>
<tr>
<td></td>
<td>AISI: L2</td>
<td>Cr ≤ 0.70</td>
</tr>
<tr>
<td></td>
<td></td>
<td>V ≤ 0.10</td>
</tr>
<tr>
<td>1.2311</td>
<td>DIN: 40 CrMnMo 7</td>
<td>C ≤ 0.40</td>
</tr>
<tr>
<td></td>
<td>AFNOR: 40 CMO 8</td>
<td>Si ≤ 0.40</td>
</tr>
<tr>
<td></td>
<td>UNI: 35 CrMo 8 KU</td>
<td>Mn ≤ 1.50</td>
</tr>
<tr>
<td></td>
<td>AISI: P20</td>
<td>Cr ≤ 1.90</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Mo ≤ 0.20</td>
</tr>
<tr>
<td>1.2312</td>
<td>DIN: 40 CrMnMo 8 6</td>
<td>C ≤ 0.40</td>
</tr>
<tr>
<td></td>
<td>AFNOR: 40 CMO 8 5</td>
<td>Si ≤ 0.40</td>
</tr>
<tr>
<td></td>
<td>UNI: 35 CrMo 8 KU</td>
<td>Mn ≤ 1.50</td>
</tr>
<tr>
<td></td>
<td>AISI: P20 +S</td>
<td>Cr ≤ 1.90</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Mo ≤ 0.20</td>
</tr>
<tr>
<td></td>
<td></td>
<td>S ≤ 0.06</td>
</tr>
<tr>
<td>1.2316</td>
<td>DIN: X38 CrMo 16</td>
<td>C ≤ 0.36</td>
</tr>
<tr>
<td></td>
<td>AFNOR: Z 35 CD 17</td>
<td>Si ≤ 0.36</td>
</tr>
<tr>
<td></td>
<td>UNI: X 38 CrMo 16 KU</td>
<td>Mn ≤ 1.20</td>
</tr>
<tr>
<td></td>
<td>AISI: ≈ 422</td>
<td>Cr ≤ 1.60</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Mo ≤ 1.20</td>
</tr>
<tr>
<td>1.2343</td>
<td>DIN: X 38 CrMoV 5</td>
<td>C ≤ 0.38</td>
</tr>
<tr>
<td></td>
<td>AFNOR: Z 38 CDV 5</td>
<td>Si ≤ 0.40</td>
</tr>
<tr>
<td></td>
<td>UNI: X 37 CrMoV 5-1 KU</td>
<td>Mn ≤ 0.40</td>
</tr>
<tr>
<td></td>
<td>AISI: H11</td>
<td>Cr ≤ 1.20</td>
</tr>
<tr>
<td>1.2343 ESU (ESR)</td>
<td>DIN: X 38 CrMoV 5</td>
<td>C ≤ 0.38</td>
</tr>
<tr>
<td></td>
<td>AFNOR: Z 38 CDV 5</td>
<td>Si ≤ 0.40</td>
</tr>
<tr>
<td></td>
<td>UNI: X 37 CrMoV 5-1 KU</td>
<td>Mn ≤ 0.40</td>
</tr>
<tr>
<td></td>
<td>AISI: H11 ESR</td>
<td>Cr ≤ 1.20</td>
</tr>
<tr>
<td>1.2344</td>
<td>DIN: X 40 CrMoV 5</td>
<td>C ≤ 0.40</td>
</tr>
<tr>
<td></td>
<td>AFNOR: Z 40 CDV 5</td>
<td>Si ≤ 0.40</td>
</tr>
<tr>
<td></td>
<td>UNI: X 40 CrMoV 5-1 KU</td>
<td>Mn ≤ 0.50</td>
</tr>
<tr>
<td></td>
<td>AISI: H13</td>
<td>Cr ≤ 1.00</td>
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<tr>
<td></td>
<td></td>
<td>Mo ≤ 1.40</td>
</tr>
<tr>
<td></td>
<td></td>
<td>V ≤ 1.00</td>
</tr>
<tr>
<td>1.2344 ESU (ESR)</td>
<td>DIN: X 40 CrMoV 5</td>
<td>C ≤ 0.40</td>
</tr>
<tr>
<td></td>
<td>AFNOR: Z 40 CDV 5</td>
<td>Si ≤ 0.40</td>
</tr>
<tr>
<td></td>
<td>UNI: X 40 CrMoV 5-1 KU</td>
<td>Mn ≤ 0.50</td>
</tr>
<tr>
<td></td>
<td>AISI: H13 ESR</td>
<td>Cr ≤ 1.00</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Mo ≤ 1.40</td>
</tr>
<tr>
<td></td>
<td></td>
<td>V ≤ 1.00</td>
</tr>
<tr>
<td>1.2363</td>
<td>DIN: X 100 CrMo 5</td>
<td>C ≤ 1.00</td>
</tr>
<tr>
<td></td>
<td>AFNOR: Z 100 CDV 5</td>
<td>Si ≤ 0.30</td>
</tr>
<tr>
<td></td>
<td>UNI: X 100 CrMo 5-1 KU</td>
<td>Mn ≤ 0.50</td>
</tr>
<tr>
<td></td>
<td>AISI: A2</td>
<td>Cr ≤ 0.50</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Mo ≤ 1.10</td>
</tr>
<tr>
<td></td>
<td></td>
<td>V ≤ 0.20</td>
</tr>
<tr>
<td>1.2379</td>
<td>DIN: X 153 CrMo 12</td>
<td>C ≤ 1.53</td>
</tr>
</tbody>
</table>
Meusburger Georg GmbH & Co KG.

For the right application. If in doubt, a specialist (e.g. steel manufacturer, hardening shop) should be consulted. Liability does not lie with this general information, which is only a recommendation for anyone to apply freely. For individual cases, the buyer must make sure they purchase the right material. For the right application, please consult the material producer.

### Material no. 1.2714
**DIN:** 56 NiCrMo7  
**AFNOR:** 55 NCDV 7  
**AISI:** L6  
**Material:** C - 0.56  
**Strength:** Cr - 1.10  
**Character:** Mo - 0.30  
**Application:** Ni - 1.70  
**V - 0.10**  
Steel for through hardening  
Good high-temperature resistance  
and toughness  
Auxiliary tools for extruders,  
hot-forging tools, dies for processing tin, lead and zinc alloys

### Material no. 1.2714 HH
**DIN:** 56 NiCrMo7  
**AFNOR:** 55 NCDV 7  
**AISI:** L6  
**Material:** C - 0.56  
**Strength:** Cr - 1.10  
**Character:** Mo - 0.30  
**Application:** Ni - 1.70  
**V - 0.10**  
Steel for through hardening,  
quenched and tempered  
Good high-temperature resistance  
and toughness  
Mould inserts, cores and slides  
for injection mould tools

### Material no. 1.2738
**DIN:** 40 Cr/MnNiMo8-6-4  
**AFNOR:** 40 CMND 8  
**AISI:** 6P20 + Ni  
**Material:** C - 0.40  
**Strength:** Mn - 1.50  
**Character:** Mo - 0.20  
**Application:** Ni - 1.10  
**Si - 0.30**  
Tool steel  
Quenched and tempered section steel  
with uniform strength  
even in plates and bars with larger dimensions;  
suitable for polishing and nitrating  
Large cavity plates with deep  
cavities for items such as  
bumpers or dashboards

### Material no. 1.2767
**DIN:** 45 NiCrMo16  
**AFNOR:** 45 NCD16  
**UNI:** 40 NiCrMo16 KU  
**AISI:** 6F7  
**Material:** C - 0.45  
**Strength:** Si - 0.40  
**Character:** Mn - 0.40  
**Application:** Mo - 0.25  
**Ni - 4.00**  
Steel for through hardening  
Special alloy suitable for  
polishing, with high resistance  
to pressure and good flexural  
strength  
High-performance cavity  
plates and inserts; cutting and  
bending inserts for high  
compressive loads

### Material no. 1.2842
**DIN:** 90 MnCrV 8  
**AFNOR:** 90 MV 8  
**UNI:** 90 MnV Cr 8 KU  
**AISI:** O2  
**Material:** C - 0.90  
**Strength:** Si - 0.20  
**Character:** Mn - 2.00  
**Application:** Mo - 0.40  
**V - 0.10**  
Steel for through hardening  
Dimensional stability and high  
hardenability; wear-resistant,  
cold-work steel with very good  
cutting properties  
Cavity plates and inserts  
exposed to abrasive stress;  
wear plates, cutting dies and  
guiding plates; pressure pads  
and guiding rails

### Material no. 1.3343
**DIN:** HS 6-5-2 C  
**AFNOR:** Z 85 WDCV 6  
**UNI:** X 82 WMoV 6.5  
**AISI:** M 2 reg. C  
**Material:** C - 0.90  
**Strength:** Si - 0.30  
**Character:** Mn - 0.30  
**Application:** Mo - 4.00  
**Cr - 1.35**  
**Mo - 0.25**  
**Ni - 4.00**  
HSS - High speed steel  
Very high resistance to adhesion  
and wear in combination with  
high toughness and compressive  
strength  
Blocks for eroding, cutting  
punches and dies  
with particularly durable edges,  
inserts with excellent wear  
resistance

### Material no. 1.3344 PM
**DIN:** PM 6-5.3  
**AFNOR:** X 130 WMoCrV 6-5.4  
**UNI:** W 6 Mo 5 Cr 4 V 3  
**AISI:** M 3-2 (PM)  
**Material:** C - 1.25  
**Strength:** Si - 0.30  
**Character:** Mn - 0.30  
**Application:** Mo - 4.00  
**Cr - 1.35**  
**Mo - 0.25**  
**V - 1.90**  
**W - 6.20**  
HSS powder metallurgy steel  
Outstanding resistance to  
adhesive and abrasive wear;  
optimal toughness and good  
through hardenability  
Blocks for eroding, cutting  
punches and dies  
with particular durability,  
inserts with excellent wear  
resistance

### Material no. 1.7131
**DIN:** 16 MnCr 5  
**AFNOR:** 16 MC 5  
**AISI:** 5115  
**Material:** C - 0.16  
**Strength:** Si - 0.25  
**Character:** Mn - 1.15  
**Application:** Cr - 0.95  
**Steel for case-hardening  
alloyed**  
Guiding elements, cores and  
machine parts

### Material no. 1.7225
**DIN:** 42 CrMo 4  
**AFNOR:** 42 CD 4  
**UNI:** 42 CrMo 4  
**AISI:** 4140  
**Material:** C - 0.42  
**Strength:** Si - 0.25  
**Character:** Mn - 0.75  
**Application:** <0.035  
**Cr - 1.10**  
**Mo - 0.22**  
**Steel for quenching and tempering  
high resistance, high toughness,  
universally useable in engineering**  
Engineering, Groundplates,  
Axes, Gear shafts, Gear wheels

**Material:** WC - 86.6  
**Character:** Co - 11.8  
The universal carbide grade -  
the ideal compromise between  
hardness and fracture toughness  
with high edge stability.  
Blocks for eroding, cutting  
punches, and dies with  
maximum wear resistance;  
active parts for stamping,  
embossing, bending, and  
forming

### Material no. 3.3547 (AW-5083)
**DIN:** AlMg 4.5 Mn  
**EN:** ISO 5083  
**AFNOR:** A G4 5MC  
**UNI:** 7790  
**Material:** Si - 0.40  
**Strength:** Fe - 0.40  
**Character:** Cu - 0.70  
**Application:** Mg - 4.40  
**Zn - 0.25**  
**Ti - 0.15**  
≤ 290 N/mm²  
Aluminium alloy  
Plates for mould bases and jigs

### Material no. 3.4365 (AW-7075)
**DIN:** AlZnMgCu 1.5  
**EN:** ISO 7075  
**AFNOR:** A Z5GU  
**UNI:** 9007/2  
**Material:** Si - 0.40  
**Strength:** Fe - 0.50  
**Character:** Cu - 1.60  
**Application:** Mg - 2.60  
**Zn - 0.23**  
**Ti - 0.20**  
≤ 540 N/mm²  
Aluminium zinc alloy  
High strength, hardened  
Plates for mould tools and dies  
with increased requirements on  
strength

### Material no. M V10 PM
**AISI:** A11  
**Material:** C - 2.45  
**Strength:** Si - 0.90  
**Character:** Mn - 0.50  
**Application:** Cr - 5.20  
**Mo - 1.30**  
**V - 9.75**  
HSS powder metallurgy steel  
Highest abrasive wear resistance  
and excellent toughness.  
Good machinability through a  
homogeneous microstructure.  
Blocks for eroding, dies and  
cutting punches with extreme  
requirements, fine blanking  
punches, pressing punches for  
sinter press

This general information is only a recommendation for anyone to apply freely. For individual cases, the buyer must make sure they purchase for the right application. If in doubt, a specialist (e.g. steel manufacturer, hardening shop) should be consulted. Liability does not lie with Meusburger Georg GmbH & Co KG.
<table>
<thead>
<tr>
<th>Material No.</th>
<th>1.0577</th>
</tr>
</thead>
<tbody>
<tr>
<td>Designation</td>
<td></td>
</tr>
<tr>
<td>DIN:</td>
<td>S 355 J2 (St 52-3)</td>
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<tr>
<td>AFNOR:</td>
<td>A 52 FP</td>
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<td>UNI:</td>
<td>-</td>
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<td>AISI:</td>
<td>A738</td>
</tr>
<tr>
<td>Indicatory analysis:</td>
<td></td>
</tr>
<tr>
<td>C</td>
<td>≤ 0.22</td>
</tr>
<tr>
<td>Si</td>
<td>≤ 0.55</td>
</tr>
<tr>
<td>Mn</td>
<td>≤ 1.60</td>
</tr>
<tr>
<td>Strength:</td>
<td>≈ 550 N/mm²</td>
</tr>
<tr>
<td>Thermal conductivity at 20 °C:</td>
<td>40 W/m K</td>
</tr>
</tbody>
</table>

| Character:           | unalloyed structural steel with good weldability |
| Application:         | for common applications in tool, mould and machine construction |

**Treatment by**

- Welding: very good weldability due to its low carbon content
- Polishing:
- Etching: not usual
- EDM: not usual
- Nitriding: not usual
- Hard chroming: not usual

**Heat treatment:**

- Soft annealing: 650 to 700 °C for about 2 to 5 hours
- slow controlled cooling of 10 to 20 °C per hour to about 600 °C;
- further cooling in air, max. 180 HB

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**Technical Tip**

- If no welding is required, we recommend 1.1730 → better machinability in spite of higher strength
Material No.: 1.1730

Designation
- DIN: C 45 U
- AFNOR: XC 48
- UNI: -
- AISI: 1045

Indicatory analysis:
- C: 0.45
- Si: 0.30
- Mn: 0.70

Strength:
- \( \approx 640 \text{ N/mm}^2 \)

Thermal conductivity at 20 °C:
- \( 50 \text{ W/m K} \)

Character:
- Unalloyed tool steel with excellent machinability; chilled cast steel, suitable for flame and inductive hardening

Application:
- Unhardened parts for mould and jig construction or plates and frames for tools and dies

Treatment by
- Polishing:
- Etching:
- EDM: not usual
- Nitriding:
- Hard chroming:

Heat treatment:
- Soft annealing: 680 to 710 °C for about 2 to 5 hours
- Slow controlled cooling of 10 to 20 °C per hour to about 600 °C; further cooling in air, max. 190 HB
- Hardening: 800 to 830 °C
- Quenching in water
- Obtainable hardness: 58 HRC
- Hardening depth: 3–5 mm
- Max. 15 mm through-hardening thickness
- Tempering:
- Slow heating to tempering temperature immediately after hardening, to 180 to 300 °C depending on desired hardness
- 1 hour per 20 mm: min. 2 hours

Tempering chart:
**Material No.:** 1.2083 / 1.2083 ESR*

**Designation**
- DIN: X 40 Cr 14
- AFNOR: Z 40 C 14
- UNI: 420 / 420 ESR
- AISI: 420 / 420 ESR

**Indicatory analysis:**
- C: 0.40
- Si: 0.40
- Mn: 0.30
- Cr: 13.00

**Strength:** ≈ 720 N/mm²

**Thermal conductivity at 100°C:** 18 W/m K

**Character:** low corrosion, high-alloy, low warpage steel for through hardening with excellent properties for mirror polishing as well as good photoetching, good machinability, high wear resistance and high dimensional stability

**Application:** mould plates and inserts for working with chemically aggressive plastics; because of excellent polishing, suitable for optical and medical products

**Treatment by**
- Polishing: can be polished in the annealed and hardened state; good preliminary surface preparation work is decisive for a good polish
- Etching: good photoetching (graining)
- Spark eroding: in the hardened and tempered condition, treat again for stress relief about 20°C below the last temperature
- Nitriding: not usual
- Hard chroming: not usual

**Technical Tip**
- cold-work steel
- must be tempered several times after hardening (max. 52HRC);
  The demand for “max. hardness” often ends up in material breakage.
- mould temperature max. 200°C
- not corrosion-resistant until after hardening
- The ESR quality guarantees an extremely pure and homogeneous microstructure.

**Heat treatment:**
- Soft annealing: 750 to 800°C for about 2 to 5 hours
  slow controlled cooling of 10 to 20°C per hour to about 650°C;
  further cooling in air, max. 200 HB
- Hardening: 1000 to 1050°C
  15 to 30 minutes keeping curing temperature
  quenching in oil/compressed gas/hot bath
  obtainable hardness: 53 - 56 HRC
- Tempering: slow heating to tempering temperature immediately after hardening;
  minimum time in furnace: 2 hours per 20 mm part thickness;
  twice tempering is recommended

<table>
<thead>
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<th>HRC</th>
<th>0</th>
<th>100</th>
<th>200</th>
<th>300</th>
<th>400</th>
<th>500</th>
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<td>36</td>
<td>40</td>
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<td>48</td>
<td>52</td>
<td>56</td>
<td>58</td>
<td>60</td>
</tr>
</tbody>
</table>

Tempering chart:
Material No.: 1.2085

Designation
DIN: X 33 CrS 16
AFNOR: Z 35 CD 17.S
UNI:  
AISI: ≈ 422 + S

Indicatory analysis:
C  0.33
Si  0.30
Mn  0.80
Cr  16.00
S  0.06
Ni  0.30

Strength:  ≈ 1080 N/mm²

Thermal conductivity at 100 °C: 18 \( \frac{W}{m \cdot K} \)

Character: corrosion resistant, high-alloy, pre-toughened tool steel with good machinability due to Sulphur (S) additive

Application: plates for corrosion resistant mould tools and die sets; moulds for corrosive plastics; the expense for protection and care of mould tools is reduced thanks to increased corrosion resistance; not suitable for mould inserts

Treatment by
Polishing:
Etching:
EDM:  
Nitriding:  
Hard chroming:  not usual

Heat treatment:
Usually no heat treatment is required.

Soft annealing:
850 to 880 °C for about 2 to 5 hours
slow controlled cooling inside the furnace; annealing hardness: max. 240 HB

Hardening:
1000 to 1030 °C
keep curing temperature for 30 minutes
quenching in oil is preferable
obtainable hardness: 48 HRC

Tempering:
slow heating to tempering temperature immediately after hardening;
minimum time in furnace: 2 hours per 20 mm part thickness;
tempering twice is recommended

Tempering chart:
Material No.: 1.2162

Designation
- DIN: 21 MnCr 5
- AFNOR: 20 MC 5
- UNI: 5120
- AISI: 5120

Indicatory analysis:
- C: 0.21
- Si: 0.25
- Mn: 1.25
- Cr: 1.20

Strength: ≥ 660 N/mm²

Thermal conductivity at 100 °C: 38.5 W/m K

Character: standard steel for case-hardening with good machinability; high surface hardness with tough core

Application: machine parts and moulding plates with a high surface hardness; synthetic resin press moulds for the processing of thermoplastics and thermosets

Treatment by
- Polishing: possible
- Etching:
- EDM:
- Nitriding: Usually, hardened parts are not nitrided → loss of hardness.
- Hard chroming: recommended, results in increased wear and corrosion resistance

Heat treatment:
- Soft annealing: 670 to 710 °C for about 2 to 5 hours, slow controlled cooling inside the furnace, further cooling in air, max. 205 HB
- Carburising: 900 to 950 °C. The choice of the carburising means and carburising temperature depends on the desired surface carbon content, the carburising graph and the required case depth.
- Case hardening: 870 to 930 °C in powder/salt bath, cooling in oil/hot bath at 160 to 250 °C
- Intermediate heat treatment: 630 to 650 °C, for about 2 to 4 hours with slow furnace cooling
- Preheating: 350 °C depending on dimensions
- Hardening: curing temperature 810 to 840 °C in warmed oil of ~ 60 °C
- Cooling: in to about 100 °C oil, then in air to about 50 °C
- Tempering: 1 hour per 20 mm part thickness, min. 2 hours

Tempering chart:

For mirror polishing we recommend the steel for through hardening 1.2767.
**Material No.:** 1.2210

**Designation**
- DIN: 115 CrV 3
- AFNOR: 100 C3
- UNI: 107 CrV 3 KU
- AISI: L2

**Indicatory analysis:**
- C: 1.18
- Si: 0.25
- Mn: 0.30
- Cr: 0.70
- V: 0.10

**Strength:**
≈ 740 N/mm²

**Thermal conductivity at 100 °C:**
33 \( \frac{W}{m \cdot K} \)

**Character:** Chrome-Vanadium alloyed **cold-work steel** with high resistance; also known as silver steel.

**Application:** small turned parts, core pins, punches and engraving tools

**Treatment by**
- Polishing:
- Etching:
- EDM: > not usual
- Nitriding:
- Hard chroming:

**Heat treatment:**
- **Soft annealing:**
  710 to 740 °C for about 2 to 5 hours
  slow controlled cooling inside the furnace: 10 to 20 °C per hour to about 600 °C further cooling in air, **max. 220 HB**
- **Hardening:**
  780 to 840 °C
  15 to 30 minutes keeping curing temperature
  quenching in water/oil
  obtainable hardness: **64−66 HRC**
- **Tempering:**
  slow heating to tempering temperature immediately after hardening;
  minimum time in furnace: 1 hour per 20 mm part thickness;
  min. 2 hours/cooling in air

**Tempering chart:**

---

**Technical Tip**
- Silver steel 1.2210 is dispatched finish-ground to h9 tolerance.
Material No.: 1.2311  
DIN: 40 CrMnMo 7  
AFNOR: 40 CMD 8  
UNI: 35 CrMo 8 KU  
AISI: P20

Indicatory analysis:  
C: 0.40  
Si: 0.40  
Mn: 1.50  
Cr: 1.90  
Mo: 0.20

Strength:  
$\approx 1080 \, \text{N/mm}^2$

Thermal conductivity at 100 °C:  
$35 \, \text{W/mK}$

Character: alloyed and pre-toughened tool steel, especially suitable for polishing; high dimensional stability

Application: moulding plates, inserts and high-tensile machine parts

Treatment by
Polishing: good suitability for polishing; at 580 °C (Meusburger standard) is recommended.
Etching: possible
EDM: possible
Nitriding: increases the steel's wear resistance
Hard chroming: particularly increases the steel's wear resistance and corrosion resistance

Heat treatment:
already pre-toughened; usually no heat treatment required
Nitriding: before nitriding, stress-relief annealing is recommended at 580 °C (Meusburger standard)
Hard chroming: after the hard chroming the mould must be annealed about 3 to 4 hours at 180 °C to avoid brittle fractures from hydrogen.
Hardening: 840 to 860 °C
Cooling: to 180 °C/220 °C in oil/hot bath, then in air to about 100 °C

obtainable hardness: 52 HRC
Tempering: slow heating to tempering temperature immediately after hardening; minimum time in furnace: 1 hour per 25 mm part thickness

Tempering chart:

![Tempering chart](image-url)
**Material No.:** 1.2312

**Designation**
- DIN: 40 CrMnMoS 86
- AFNOR: 40 CMD 8.S
- UNI: -
- AISI: P20 + S

**Indicatory analysis:**
- C: 0.40
- Si: 0.40
- Mn: 1.50
- Cr: 1.90
- Mo: 0.20
- S: 0.06

**Strength:**
- $\approx 1080$ N/mm²

**Thermal conductivity at 100 °C:**
- $35 \frac{W}{m \cdot K}$

**Character:**
- alloyed and pre-toughened tool steel, with excellent machinability in the hardened condition because of the Sulphur additive;
- high dimensional stability

**Application:**
- plates for mould tools and dies with increased requirements on strength;
- high-tensile machine parts

**Treatment by**
- Polishing:
  - technical polishing possible; for higher surface requirements we recommend 1.2311 or 1.2738
- Etching:
  - not recommended
- EDM:
- Nitriding:
  - increases the steel's wear resistance

**Heat treatment:**
- already pre-toughened, usually no heat treatment required
- Nitriding:
  - before nitriding, stress-relief annealing at 580 °C (Meusburger standard) is recommended
- Hardening:
  - 840 to 860 °C
- Cooling:
  - to 180 °C/220 °C in oil/hot bath
  - obtainable hardness: 52 HRC
- Tempering:
  - slow heating to tempering temperature immediately after hardening;
  - minimum time in furnace: 1 hour per 25 mm part thickness.

**Tempering chart:**

- For increased surface quality requirements, use material grade 1.2311.
Material No.: 1.2316

Designation:
- DIN: X 38 CrMo 16
- AFNOR: Z 35 CD 17
- UNI: X 38 CrMo 16 KU
- AISI: ≈ 422

Indicatory analysis:
- C: 0.36
- Cr: 16.00
- Mo: 1.20

Strength: ≈ 1010 N/mm²

Thermal conductivity at 100 °C: 18 W/m K

Character: corrosion resistant, high-alloy, polishable, pre-toughened tool steel
Application: moulds for processing corrosive plastics

Treatment by
- Polishing: good suitability
- Etching: possible
- EDM: possible
- Nitriding: reduces the corrosion resistance

Heat treatment:
- already pre-toughened; usually no heat treatment required

Soft annealing:
760 bis 800 °C, for about 4 to 5 hours
slow controlled cooling of 10 to 20 °C per hour to about 650 °C
further cooling in air, max. 230 HB

Hardening:
1030 to 1050 °C
15 to 30 minutes keeping curing temperature
quenching in water/oil
obtainable hardness: 49 HRC

Tempering:
slow heating to tempering temperature immediately after hardening;
minimum time in furnace: 1 hour per 20 mm part thickness

Tempering chart:

Technical Tip:
- corrosion resistant like 1.2085
- for demanding surfaces
Material No.: 1.2343 / 1.2343 ESR*

Designation
- DIN: X 38 CrMoV 5-1
- AFNOR: Z 38 CDV 5
- UNI: X 37 CrMoV 5-1 KU
- AISI: H11 / H11 ESR

Indicatory analysis:
- C: 0.38
- Si: 1.00
- Mn: 0.40
- Cr: 5.30
- Mo: 1.20
- V: 0.40

Strength: $\approx 780 $ N/mm²

Thermal conductivity at 200 °C: 27 W/m K

Character: high-alloy hot-work steel with high toughness and heat resistance, hot cracks resistance and good thermal conductivity; for very high requirements available in grade *ESR (Electro-Slag Remelted)

Application: moulding plates and inserts for plastic injection mould tools; *ESR for die casting applications (Al, Mg, Zn)

Treatment by
- Polishing: highly suitable
- Etching: very easily feasible (graining)
- EDM: in the hardened and tempered condition, treat again for stress relief about 20 °C below the last tempering temperature
- Nitriding: increases the wear resistance and prevents the bonding of casting material

Heat treatment:
- Soft annealing: 750 to 800 °C, about 4 to 5 hours
- slow controlled cooling inside the furnace: 10 to 20 °C per hour to about 600 °C; further cooling in air, max. 205 HB

Nitriding: before nitriding, stress-relief annealing at 580 °C (Meusburger standard) is recommended.
- A treatment at 525 °C in ammonia gas results in a surface hardness of approx. 55 HRC.
- Hardening: 1000 to 1040 °C
- keep curing temperature for 15 to 30 minutes
- quenching in water/oil/air
- obtainable hardness: 50–56 HRC

Tempering:
- slow heating to tempering temperature immediately after hardening;
- minimum time in furnace: 1 hour per 20 mm part thickness;
- repeated tempering is recommended

Heat treatment chart:

High temperature strength chart:

- susceptible to corrosion; during machining, continuous corrosion protection has to be ensured (especially during wire EDM)
- 1.2343 ESR is highly suitable for mirror polishing
Material No.: 1.2344 / 1.2344 ESR*

Designation
DIN: X 40 CrMoV 5-1
AFNOR: Z 40 CDV 5
UNI: X 40 CrMoV 5-1 KU
AISI: H13 / H13 ESR

Indicatory analysis:
C 0.40
Si 1.00
Cr 5.30
Mo 1.40
V 1.00

Strength:
≥ 780 N/mm²

Thermal conductivity at 100 °C:
26 W/m K

Character:
high-alloy hot-work steel, high heat resistance, high wear resistance, good toughness, thermal conductivity and hot cracks resistance, limited use for water cooling; for very high requirements available in grade *ESR (Electro-Slag Remelted)

Application:
standard material for hot-work tools, extrusion moulds, dies, tools for plastic processing

Treatment by
Polishing:
Etching:
EDM:
Nitriding:
Hard chrome plating: in special cases

Heat treatment:
Soft annealing:
750 to 800 °C for about 4 to 5 hours
slow controlled cooling inside the furnace: 10 to 20 °C per hour to about 600 °C
further cooling in air, max. 230 HB

Hardening:
1020 to 1060 °C
15 to 30 minutes keeping curing temperature
quenching in water/oil
obtainable hardness: 54 HRC

Tempering:
slow heating to tempering temperature immediately after hardening;
minimum time in furnace: 1 hour per 20 mm part thickness

Tempering chart:

Technical Tip
- susceptible to corrosion; during machining, continuous corrosion protection has to be ensured (especially during wire EDM)

- 1.2344 ESR is highly suitable for mirror polishing
Material No.: 1.2363

Designation:
- DIN: X 100 CrMoV 5
- AFNOR: Z 100 CDV 5
- UNI: X 100 CrMoV 5-1 KU
- AISI: A2

Indicatory analysis:
- C: 1.00
- Si: 0.30
- Mn: 0.50
- Cr: 5.20
- Mo: 1.10
- V: 0.20

Strength: $\approx 810 \text{ N/mm}^2$

Thermal conductivity at 100°C: \(19 \frac{W}{mK}\)

Character: steel for through hardening with good machinability, high wear resistance and low warpage; very good dimensional stability, toughness and through hardenability

Application: mould plates and inserts as well as cutting punches, wear plates and cutting dies with high requirements on toughness

Treatment by:
- Polishing:
- Etching:
- Nitriding:
- Hard chroming: > possible

Heat treatment:
- Soft annealing: 800 to 840°C for about 4 - 5 hours
- slow controlled cooling inside the furnace: 10 to 20°C per hour to about 650°C
- further cooling in air, max. 230 HB

Hardening:
- 950 to 980°C
- quenching in calm air
- obtainable hardness: 62 HRC

Tempering:
- slow heating to tempering temperature immediately after hardening;
- tempering twice is recommended; rapid cooling following the tempering improves the dimensional stability;
- maximum hardness achievable after tempering: 58–60 HRC

Tempering chart:
**Material No.:** 1.2379  
**Designation**  
DIN: X 153 CrMoV 12  
AFNOR: Z 160 CDV 12  
UNI: -  
AISI: ≈ D2

<table>
<thead>
<tr>
<th>Indicator analysis:</th>
</tr>
</thead>
</table>
| C | 1.53  
| Si | 0.30  
| Mn | 0.35  
| Cr | 12.00  
| Mo | 0.80  
| V | 0.80  

| Strength: | ≈ 850 N/mm²  

| Thermal conductivity at 100 °C: | 21 W/m K  

**Character:** high-alloy steel for through-hardening with moderate machinability; extremely wear resistant and low warpage, good dimensional stability, toughness and through hardenability

**Application:** mould plates and inserts as well as cutting punches, wear plates and cutting dies with high requirements for wear resistance

**Treatment by**  
Polishing: possible when hardened  
Nitriding: very well suited, due to the fact that the hardness of the base material will not fall below 60 HRC  
EDM: possible, Structure eroding not possible  
Hard chroming: possible  
Etching: not possible, coarse carbides are washed out

**Heat treatment:**  
Soft annealing:  
800 to 850 °C for about 2 to 5 hours  
slow controlled cooling of 10 to 20 °C per hour to about 600 °C  
further cooling in air, max. 235 HB

Hardening:  
curing temperature: see tempering chart  
quenching in oil/air/hot bath  
obtainable hardness: 63–65 HRC

Tempering:  
slow heating to tempering temperature (to avoid forming of cracks) immediately after hardening;  
triple tempering at max. secondary hardening temperature is recommended;  
rapid cooling following the tempering improves the dimensional stability;  
maximum hardness achievable after tempering: 60–62 HRC

**Tempering chart:**

![Tempering chart](image-url)
Material No.: 1.2714

Designation
DIN: 56 NiCrMoV 7
AFNOR: 55 NCDV 7
UNI: L6
AISI: L6

Indicatory analysis:
C 0.56
Cr 1.10
Mo 0.50
Ni 1.70
V 0.10

Strength:
\( \approx 850 \text{ N/mm}^2 \)

Thermal conductivity at 100 °C:
\( 36 \frac{\text{W}}{\text{mK}} \)

Character:
steel for through hardening with good heat resistance, high temperature resistance, through hardenability and toughness

Application:
extrusion dies, hot-forging tools, dies for processing tin, lead and zinc alloys

Treatment by
Polishing: technical polishing possible
Etching:
EDM: possible
Nitriding:
Hard chroming:

Heat treatment:
Soft annealing:
650 to 700 °C for about 4 to 5 hours
slow controlled cooling inside the furnace: 10 to 20 °C per hour to about 600 °C
further cooling in air, max. 248 HB

Hardening:
950 to 980 °C
keep curing temperature for 15 to 30 minutes
quenching in water/oil
obtainable hardness: 56 HRC

Tempering:
slow heating to tempering temperature immediately after hardening;
mimum time in furnace: 1 hour per 20 mm part thickness

Tempering chart:
Material No.: 1.2714 HH

Designation
DIN: 56 NiCrMoV 7
AFNOR: 55 NCDV 7
UNI: -
AISI: L6

Indicatory analysis:
C 0.56
Cr 1.10
Mo 0.50
Ni 1.70
V 0.10

Strength: through-hardened to 1320 N/mm² (∼42HRC)

Thermal conductivity at 100 °C: $36 \frac{W}{m\cdot K}$

Character: steel for through hardening, quenched and tempered, with good heat resistance, hardenability and toughness

Application: mould inserts, cores and slides for injection mould tools

Treatment by
Polishing: technical polishing possible
Etching:
EDM:
Nitriding: possible
Hard chroming:

Heat treatment:
Soft annealing:
650 to 700°C for about 4 to 5 hours
slow controlled cooling of 10 to 20 °C per hour to about 600 °C
further cooling in air, max. 248 HB

Hardening:
950 to 980 °C
keep curing temperature for 15 to 30 minutes
quenching in water/oil
obtainable hardness: 56 HRC

Tempering:
slow heating to tempering temperature immediately after hardening;
minimum time in furnace: 1 hour per 20 mm part thickness

Tempering chart:
Material No.: 1.2738

Designation in

- DIN: 40 CrMnNiMo 8-6-4
- AFNOR: 40 CMND 8
- UNI: ≈ P20 + Ni / ≈ P20 + Ni mod.

Indicatory analysis:

- C: 0.40
- Mn: 1.50
- Cr: 1.90
- Mo: 0.20
- Ni: 1.10
- Si: 0.30

Strength: ≈ 1080 N/mm²

Thermal conductivity at 100°C: 33.5 W/m K

Character: low-sulfer mould steel, supplied in quenched condition; because of the nickel-content constant strength with maximum dimensions

Application: large mould tools with high loads at core, moulds for bumpers, dashboards, moulding frames

Treatment by

- Etching:
- Spark eroding:
- Nitriding: is recommended
- Hard chroming: suitable

Heat treatment: already pre-toughened, generally no heat treatment required

- Annealing:
  - 710 to 740°C for about 2 - 5 hours
  - slow controlled cooling of 10 to 20°C per hour to about 600°C
  - further cooling in air, max. 235 HB

- Hardening:
  - 840 to 870°C
  - 15 to 30 minutes keeping curing temperature
  - quenching in oil/heat bath/air 180 to 220°C
  - obtainable hardness: 53 HRC

- Tempering:
  - slow heating to tempering temperature immediately after hardening;
  - minimum time in furnace: 1 hour per 20 mm part thickness;
  - tempering twice is recommended

- Tempering chart:
**Material No.:** 1.2767

**Designation in**
- DIN: 45 NiCrMo 16
- AFNOR: 45 NCD 16
- UNI: 40 NiCrMoV 16 KU
- AISI: ≈ 6F7

**Indicatory analysis:**
- C: 0.45
- Si: 0.25
- Mn: 0.40
- Cr: 1.35
- Mo: 0.25
- Ni: 4.00

**Strength:**
- ≈ 830 N/mm²

**Thermal conductivity at 100°C:**
- 30 W/m K

**Character:** Nickel alloyed steel for through hardening, moderate machinability, very high resistance against bending and compressive strength, very high toughness and good through hardenability, also with bigger sections.

**Application:**
- Difficult mould plates and inserts for the processing of plastics with high surface requirements (mirror polishing);
- Stamping, forming, bending dies for particularly high pressure and bending stresses.

**Treatment by**
- Soft annealing:
  - 610 to 650°C for about 2 - 5 hours
  - Slow controlled cooling of 10 to 20°C per hour to about 600°C
  - Further cooling in air, max. 260 HB

- Hardening:
  - 840 to 870°C
  - Quenching in oil/warm bath/air
  - Obtainable hardness: 53 - 58 HRC

- Tempering:
  - Slow heating to tempering temperature immediately after hardening;
  - Minimum time in furnace: 1 hour per 20 mm part thickness;
  - Tempering twice is recommended

**Heat treatment:**

![Tempering chart](chart)

- To avoid undesirable distortion in spraying of plastics, the tempering temperature after hardening must be 50°C over operation temperature.
**Material No.:** 1.2842

**Designation**
- DIN: 90 MnCrV 8
- AFNOR: 90 MV 8
- UNI: 90 MnVCr 8 KU
- AISI: ≈ O2

**Indicatory analysis:**
- C: 0.90
- Si: 0.20
- Mn: 2.00
- Cr: 0.40
- V: 0.10

**Strength:**
- ≈ 760 N/mm²

**Thermal conductivity at 100 °C:** 33 \( \frac{W}{mK} \)

**Character:** steel for through-hardening with good machinability and high wear resistance; low warping and high dimensional stability; with high toughness and through hardenability (uniform hardness for cross sections up to 40 mm)

**Application:** cavity plates and inserts exposed to abrasive stress; cutting punches; wear plates, cutting dies and guiding plates; pressure pads and guiding rails

**Treatment by**
- Polishing:
- Etching: not usual → 1.2379
- Nitriding:
- EDM: is possible
- Hard chrome plating:

**Heat treatment:**
- Soft annealing: 680 to 720 °C for about 2 to 5 hours
- slow controlled cooling of 10 to 20 °C per hour to about 600 °C
- further cooling in air, max. 220 HB

- Hardening: 790 to 820 °C
- quenching in oil/hot bath (200 to 250 °C)
- obtainable hardness: 63–65 HRC

- Tempering:
  - slow heating (to avoid forming of cracks) to tempering temperature immediately after hardening;
  - twice tempering with intermediate cooling down to 20 °C increases the steel’s toughness
  - max. obtainable hardness after tempering: 58–60 HRC

**Tempering chart:**

Technical Tip:
- Steel grade 1.2510 is an adequate alternative with regards to its properties, machinability and dimensional stability after heat treatment.
Material No.: 1.3343 (HSS)  

**Designation**
- DIN: HS 6-5-2 C  
- AFNOR: Z 85 WDCV 6  
- UNI: X 82 WMoV 6 5  
- AISI: M 2 reg. C

**Indicatory analysis:**
- C: 0.9  
- Si: 0.3  
- Mn: 0.3  
- Cr: 4.0  
- Mo: 5.0  
- V: 1.9  
- W: 6.2

**Strength:**  
- ≈ 920 N/mm²

**Thermal conductivity at 100°C:**  
- 27.4 W/m K

**Character:**  
high-speed steel featuring high resistance to adhesive and abrasive wear in combination with high toughness and compressive strength.

**Application:**  
blocks for eroding, cold forming tools such as cutting, fine blanking and impact extrusion punches and dies  
inserts with a very high wear resistance

**Treatment by**
- Polishing: suitable  
- Nitriding: highly suitable  
- EDM: highly suitable for EDM  
- Coating: highly suitable

**Heat treatment:**
- Soft annealing:  
  820 to 850 °C, about 2 to 5 hours  
  slow controlled cooling inside the furnace: 10 to 20°C per hour to about 55°C;  
  then further cooling in air. max. 270 HB

- Hardening:  
  1190 - 1230 °C  
  quenching in oil/compressed gas/air/hot bath  
  obtainable hardness: 66 HRC

- Tempering:  
  slow heating to tempering temperature (to avoid forming of cracks)  
  immediately after hardening;  
  triple tempering is recommended

**Tempering chart:**

**Technical Tip**
- excellent for PVD and CVD coating; highest dimensional stability because the steel was tempered at more than 520 °C.
<table>
<thead>
<tr>
<th>Material No.: 1.3344 PM (PM23)</th>
</tr>
</thead>
</table>

**Designation**
- DIN: PM 6-5-3
- AFNOR: X 130 WMoCrV 6-5-4-3
- UNI: W 6 Mo 5 Cr 4 V 3
- AISI: M 3-2 (PM)

**Indicatory analysis:**
- C: 1.25
- Si: 0.30
- Mn: 0.30
- Cr: 4.0
- Mo: 5.0
- V: 3.0
- W: 6.2

**Strength:**
- \( \approx 870 \text{ N/mm}^2 \)

**Thermal conductivity at 100 °C:**
- \( 24 \frac{W}{m \cdot K} \)

**Character:**
- Powder metallurgy high-speed steel with good machinability, high resistance to adhesive and abrasive wear, with optimal toughness due to the uniform and fine carbide structure, very good through hardenability and high dimensional stability

**Application:**
- Blocks for eroding, cutting punches and dies with particularly durable edges, inserts with excellent wear resistance

**Treatment by Heat treatment:**
- **Polishing:**
  - Best metallurgical properties for mirror finish
- **Nitriding:**
  - Highly suited for nitriding
- **EDM:**
  - Highly suited for EDM
- **Coating:**
  - Highly suited for coating
- **Soft annealing:**
  - At 860 to 880 °C, for approx. 2 to 5 hours
  - Slow controlled cooling of 10 to 20 °C per hour to about 600 °C; further cooling in air, max. 260 HB
- **Hardening:**
  - Curing temperature: see tempering chart
  - Quenching in oil/compressed gas/air/hot bath
  - Obtainable hardness: 64–66 HRC
- **Tempering:**
  - Slow heating to tempering temperature (in order to avoid formation of cracks) immediately after hardening; tempering three times is recommended

**Technical Tip:**
- Excellent for PVD and CVD coating; highest dimensional stability because the steel was tempered at more than 520 °C.

**Technical Tip:**
- Best metallurgical properties for mirror finish

**Tempering chart:**

![Tempering chart](image-url)
Material No.:

1.7131

Designation

DIN: 16 MnCr 5
AFNOR: 16 MC 5
UNI: -
AISI: 5115

Indicatory analysis:

C 0.16
Si 0.25
Mn 1.15
Cr 0.95

Strength: 600 N/mm²

Thermal conductivity at 20 °C: 44 W/m K

Character: steel for case hardening for parts requiring a core strength of 800 to 1000 N/mm² and high wear resistance

Application:

guiding elements, cores and machine parts with high surface hardness;
synthetic resin press moulds for processing thermoplastics and thermosetting plastics

Treatment by

Polishing:
Etching: possible
EDM:
Nitriding:
Usually, hardened parts are not nitrided → loss of hardness.
Hard chroming:
recommended, increases wear and corrosion resistance

Heat treatment:

Soft annealing:
670 to 710 °C for about 2 to 5 hours
slow controlled cooling, further cooling in air, max. 205 HB

Carburising:
900 to 950 °C. The choice of the carburising means and carburising temperature depends on the desired surface carbon content, the carburising graph and the required case depth.

Case hardening:
870 to 930 °C in powder/salt bath, cooling in oil/hot bath at 160 to 250 °C

Intermediate heat treatment:
630 to 650 °C, for about 2 to 4 hours with slow cooling inside the furnace

Preheating:
350 °C depending on dimensions

Hardening:
curing temperature 810 to 840 °C - harden in 60 °C hot oil
Cooling:
down to about 100 °C in oil, then in air to about 50 °C

Tempering:
1 hour per 20 mm part thickness, min. 2 hours
Tempering: 150 °C - 200 °C
Material No.: 1.7225

Designation:
- DIN: 42 CrMo 4
- AFNOR: 42 CD 4
- UNI: 42 CrMo 4
- AISI: 4140

Indicatory analysis:
- C 0.42
- Si 0.25
- Mn 0.75
- S <0.035
- Cr 1.10
- Mo 0.22

Strength: ~720 N/mm²

Tensile strength: heat treated max. 720 N/mm²

Thermal conductivity at 20°C: 42.6 \( \frac{\text{W}}{\text{m K}} \)

Character: alloyed steel, suitable for quenching and tempering, with high resistance and high toughness; universally useable in engineering when toughened and pre-hardened

Application: machine construction, base plates, axes, gear shafts, gear wheels

Treatment by
- Nitriding: suitable
- Welding: not recommended
- EDM: suitable for EDM
- Coating: suitable

Heat treatment:
- Normalizing: 840 to 880 °C afterwards air cooling
  some components need tempering afterwards
- Soft annealing: 680 to 720 °C, about 2 to 5 hours
  slow controlled cooling of 10 to 20 °C per hour to about 600 °C
  then further cooling in air; max. 217 HB
- Toughening: max. 1.600 N/mm²
- Hardening: 820 to 880 °C
  quenching in oil or water
  oil hardening for thin and complex,
  water hardening for large and simple components
  obtainable hardness: 53–61 HRC
- Tempering: slow heating to temperature (to avoid forming of cracks)
  immediately after hardening; at least 60 minutes
  cooling in air

Tempering chart:
### Material No.: CF-H40S+

**Designation**
- ISO: K40
- US Industry: C11/C12

**Chemical composition (%):**
- WC: 86.6
- Co (Binder): 11.8
- Other: 1.6

### Physical and mechanical characteristics:

- **Average WC grit size:** fine
- **Density (ISO 3369):** 14.15 g/cm³
- **Hardness (ISO 3878):** 1400 HV10
- **Flexural strength (ISO 3327):** 3200 MPa
- **Compressive strength:** 4900 MPa
- **Elastic modulus:** 551 GPa
- **Fracture toughness:** 12.5 MPa m$^{1/2}$
- **Thermal conductivity at 100 °C:** 90 W/mK
- **Coefficient of thermal expansion (20-400°C):** 5.4 10^{-6}/K
- **Corrosion resistance:** Yes

### Character:
The universal carbide grade - the ideal compromise between hardness and fracture toughness with high edge stability.

### Applications:
Blocks for eroding, cutting punches, and dies with maximum wear resistance; active parts for stamping, embossing, bending, and forming.

### Treatment by
- Polishing: well-suitable
- EDM: suitable
- Coating: suitable
- Laser cutting: suitable

### Typical microstructure view:
![Typical microstructure view](image)
Material No.: 3.3547

Designation
DIN: AlMg4,5Mn / ISO 5083
AFNOR: A - G4,5MC
UNI: 7790
AISI: -

Indicatory analysis:
Si 0.40
Fe 0.40
Cu 0.10
Mn 0.40–1.00
Mg 4.00–4.90
Cr 0.05–0.25
Zn 0.25
Ti 0.15

Strength: ≈ 230–290 N/mm² (depending on the thickness)

Thermal conductivity at 100 °C: 110–140 \( \frac{W}{m \cdot K} \)

Character: not hardenable, homogenised, annealed aluminium alloy with particularly good machining and welding properties; excellent dimensional stability; ideally suited for anodising, hard chromium plating and chemical nickel plating; very high resistance to corrosion

Density: 2.66 kg/dm³
Thermal expansion coefficient: 24.2 \( 10^{-6} m/mK \)
Max. temperature permanent/short term: 90/110 °C

Application: plates for mould tools, rotary tables, machined components for machine and jig construction, moulds for prototypes and foamed parts

Treatment by
Polishing: suitably
EDM: suitably
Etching: suitably
Milling: ideally suited
Welding: ideally suited

Heat treatment:

Note: Subsequent heat treatment may lead to a deterioration of the mechanical properties!
Material No.: 3.4365

Designation
DIN: AlZnMgCu 1.5 / ISO 7075
AFNOR: A · Z5GU
UNI: 9007 / 2
AISI: 

Indicatory analysis:
Si 0.40
Fe 0.50
Cu 1.20−2.00
Mn 0.30
Mg 2.10−2.90
Cr 0.18−0.28
Zn 5.10−6.10
Ti 0.20

depending on the thickness of the plate

<table>
<thead>
<tr>
<th>plate thickness [mm]</th>
<th>10</th>
<th>20</th>
<th>50</th>
<th>60</th>
<th>80</th>
<th>90</th>
<th>100</th>
<th>120</th>
<th>150</th>
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<tr>
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<td>530</td>
<td>525</td>
<td>495</td>
<td>490</td>
<td>460</td>
<td>410</td>
<td>360</td>
<td>360</td>
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<tr>
<td>yield point Rpo2 [N/mm²]</td>
<td>470</td>
<td>470</td>
<td>460</td>
<td>440</td>
<td>420</td>
<td>390</td>
<td>360</td>
<td>300</td>
<td>260</td>
<td>240</td>
</tr>
</tbody>
</table>

Thermal conductivity at 100 °C: 130−160 $\frac{W}{mK}$

Character:
hardened, high-strength aluminium zinc alloy with good properties for structure-etching, as well as good machinability, EDM and polishing properties
Density: 2.8 $kg/dm^3$
Thermal expansion coefficient: 23.4 $10^{-6} m/mK$
Max. temperature permanent/short term 90/120 °C

Application:
plates for mould tools and dies with increased requirements on strength; components for machine and jig construction

Treatment by
Polishing: possible
Milling:
EDM:
Etching: suitable for structure-etching
Repair welding: not suitable for welding

Heat treatment:
Note:
Subsequent heat treatment may lead to a deterioration of the mechanical properties.
Material No.: M V10 PM

Designation
AISI: A11 (PM)

Indicatory analysis:

<table>
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<th>Element</th>
<th>Composition</th>
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<tr>
<td>C</td>
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<td>Si</td>
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<tr>
<td>Mn</td>
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<td>Cr</td>
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<td>Mo</td>
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<td>V</td>
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</tbody>
</table>

Strength: ≈ 950 N/mm²

Thermal conductivity at 100 °C: 20 $\frac{W}{m \cdot K}$

Character: Powder metallurgical high-speed steel with optimal dimensional accuracy after the heat treatment. Highest abrasive wear resistance and excellent toughness. Good machinability through a homogeneous microstructure.

Application: Blocks for eroding, dies and cutting punches with extreme requirements, fine blanking punches, pressing punches for sinter press tools

Treatment by

- Polishing: best metallurgical properties for mirror polishing
- Nitriding: highly suitable for nitriding
- EDM: highly suitable for EDM
- Coating: highly suitable

Heat treatment:

- Soft annealing:
  880 to 900 °C, about 2 to 5 hours
  slow controlled cooling of 10 to 20 °C per hour
  to about 600 °C; further cooling in air, max. 280 HB

- Hardening:
  Curing temperature: see tempering chart
  quenching in oil/compressed gas/air/hot bath
  obtainable hardness: 60-63 HRC

- Tempering:
  slow heating to tempering temperature (to avoid forming of cracks)
  immediately after hardening;
  triple tempering is recommended

Technical Tip

- Due to the high vanadium content the steel is enriched with small, hard carbides. This guarantees optimum edge stability with maximum abrasive wear resistance.

- Ideally suitable for highly stressed parts with complicated geometries.
Steel of best quality
Meusburger stands for products of finest quality. Steel is delivered from the most famous European steel mills and is being stress-relieved in house with great care. This unique procedure guarantees our customers a low warping subsequent machining. Thanks to the temperature being maintained for a long time and slow cooling of the oven at the rate of 35°C/h we obtain the best results in terms of stress-relieved material.

Cold-work steel
Cold-work steel is used for tools that are generally operated at a temperature lower than 200°C. The high alloy cold-work steel grades offer a high wear resistance combined to a good compressive strength. The low alloy grades and those having a low carbon content offer a higher toughness and sufficient compressive strength with a reduced wear resistance.
Other noteworthy features are: Economic machinability, cold formability, well polishable and sufficiently resistant against aggressive plastics.

Hot-work steel
The permanent operation temperature of hot-work steel is above 200°C. The hot-work steel thus offers best properties for tools designed to process high performance plastics. Further applications are in the field of die casting, extrusion and die forging.
The following properties are expected of hot-work steel: high thermal resistance and toughness, high hot-wear resistance and high thermal shock resistance.