CarTech® MP35N Alloy

High strength and corrosion resistance Co-Ni-Mo based multiphase alloy

**Caractéristiques et Particularités**

The multiphase Co-Ni-Mo-based alloy CarTech® MP35N is melted VIM and remelted VAR. It allows obtaining very mechanical properties by cold working and aging preserving its very good corrosion resistance. Its high work-hardening capacity is due to the progressive micro-structural transformation of its annealed cfc-cubic phase into a twinned hcp-hexagonal phase. The final aging stabilizes its microstructure. The high corrosion resistance, fatigue resistance, designates it as implant for joint replacement, and in aerospace, medical, surgical and dental applications. The high elastic properties show it for high quality springs and components for watch movements and their exterior. This alloy is biocompatible and paramagnetic. As wires, it is well adapted for stimulation and pacer lines, drilling lines working in aggressive mediums, marine lines.

**Uses**

The CarTech® MP35N Alloy is the alloy of choice when toughness, ductility, fatigue, corrosion and wear resistances are required, as in the chemical industry, or for applications as orthopedic implants, or for medical, surgical and dental instruments, and components for watches, or the aerospace industry, micro-engineering etc.

**Standards**

<table>
<thead>
<tr>
<th>Material number</th>
<th>ASTM/ANSI</th>
<th>UNS</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.4782</td>
<td>F562</td>
<td>R30035</td>
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<tr>
<td>5758, 5844 and 5845</td>
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**Chemical composition**

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<tr>
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<tbody>
<tr>
<td>0.02</td>
<td>0.15</td>
<td>0.15</td>
<td>0.015</td>
<td>0.010</td>
<td>21.00</td>
<td>9.00</td>
<td>33.00</td>
<td>0.010</td>
<td>1.00</td>
</tr>
</tbody>
</table>

**Dimensions**

- Bars: ø 6.35 - 26 mm, cold drawn, 3 m straightened and ground UTS/Rm and A% see Figure 2
- Wires: cold drawn, on spools <1.10 mm UTS/Rm < 1100 MPa, A% according to cold reduction rate cold dawn surface « skin pass »
- Tolerances: h6 – h8

**Machining Strength**

- The CarTech® MP35N Alloy is (relatively) difficult to machine.
- In the annealed condition: not advisable, strong tendency to galling
- UTS/RM "optimal" range for the classical machining is typically ≈1200-1400 MPa up to 1050-1600 MPa.

**Machine-tools**

- The CarTech® MP35N Alloy is though.
- The toughness of this alloy is somewhat comparable to high Nitrogen stainless steel, like CHRONIFER 108. Consequently, the machining requires particularly rigid machining equipment like machine-tools, tool-fixtures and tools. High damping tool-fixtures are recommended.

**Machinability**

- Machinability: difficult
- Cutting speed: low, Vc = 20-40 m/min
- Feed: moderate to high
- Lubricant-coolant: individual choice
- The optimal cutting conditions depend on the machine tool, the cutting tools, the chip dimensions, the lubricant-cooling fluid, as well as the tolerances and the surface roughness to be achieved.

**Availability**

Standard dimensions on stock, see: Delivery program
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Melting and Remelting
- Melting: VIM (Vacuum Induction Melting) + Remelting: VAR (Vacuum Arc Remelting)

Cleanliness
- Clean alloy melted and remelted in vacuum

Figure 1
Cold deformation

![Graph showing UTS/Rm & YS_{0.2}/R_{0.2} vs. Amount of cold deformation by drawing (%)]

- The hardening of the CarTech® MP35N Alloy during cold working is based on the microstructural transformation from a cfc - cubic face centered - into an hcp - hexagonal compact – microstructure with twins formation.

Figure 2
UTS/Rm & YS_{0.2}/R_{0.2} Cold working hardening + aging

![Graph showing UTS/Rm & YS_{0.2}/R_{0.2} vs. Amount of cold work prior to aging (%)]

- Figures 1 and 2 show that an aging treatment contributes marginally only to the strengthening as measured by UTS/Rm but much more strongly the YS_{0.2}/R_{0.2} elastic properties up to 35% prior cold reduction.
The CarTech® MP35N Alloy exhibits a high ductility during cold working and after aging. The HRc hardness follows a similar pattern as the UTS/Rm and YS$_{0.2}$/R$_{0.2}$ strengths.
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Cold forming
- Warm: Forging: 1175°C minimum: 870°C
- Cold: The temperature of the cold deformation is limited to <425°C

Heat treatments
- Annealing: 1040-1095°C/1-4h/slow air cooling, air or protective atmosphere
- Aging: The aging activation is independent of a prior cold deformation
- Aging: 425-650°C / 2-5h preferably in vacuum 10⁻⁵ T or argon
  A heat treatment in air forms a yellowish oxidation layer on the surface.
- Aging: Optimal treatment after cold working <425°C:
  535-590°C/4h/slow cooling in air or protective atmosphere

Susceptibilité à la fragilisation par H₂
- The CarTech® MP35N Alloy is not sensitive to hydrogen

Microstructure
Delivery condition: annealed and annealed + cold working: multiphase cfc-hcp
Microstructure for machining: cold worked >15-25%, up to ≈ 1350 MPa
Optimal structure for polishing: cold deformed microstructure >15% reduction

Polissage
- Well adapted to the "haut de gamme" requirements of the watch making.

Laser marking
- The heat developed in the HAZ (Heat affected Zone) (ZAT) by a typical laser marking without over heating, does normally not affect the microstructure and its mechanical properties and more particularly its fatigue properties. More info

Surface cleaning
- It is highly recommended to select cleaning, pickling and passivation procedures and products adapted to Co base alloys.

Pickling
- Strong pickling solution:
  5% Fluor hydric acid + 12% nitric acid / boiling solution
  + intensive rinsing with warm or cold water and final drying
- Pickling solution for finished or fine products:
  1. Phosphoric acid 6%/ 70°C / 15-20 minutes
  2. Nitric acid 30%/40°C / 2 to 3 minutes
  3. Hydrochloric acid 40% + nitric acid 5% / room temperature
  4. Passivation: nitric acid 40% / 25°C
  1-4. + intensive rinsing with warm or cold water and final drying

Corrosion resistance
- The CarTech® MP35N Alloy exhibits a good to very good corrosion resistance in the human body, marine, drilling and oil and gas extraction.

<table>
<thead>
<tr>
<th>Medium</th>
<th>Resistance</th>
<th>Medium</th>
<th>Resistance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sea water</td>
<td>excellent</td>
<td>Sodium hydroxide</td>
<td>good</td>
</tr>
<tr>
<td>NaCl spray</td>
<td>excellent</td>
<td>Nitric acid</td>
<td>good</td>
</tr>
<tr>
<td>Humidity</td>
<td>excellent</td>
<td>Sulfuric acid</td>
<td>good</td>
</tr>
<tr>
<td>Acidic Oil/gas</td>
<td>excellent</td>
<td>Phosphoric acid</td>
<td>good</td>
</tr>
<tr>
<td>Vinegar acid</td>
<td>excellent</td>
<td></td>
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</tbody>
</table>

Biocompatibility
- The CarTech® MP35N Alloy is biocompatible.
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- The CarTech® MP35N Alloy has a good to very good fatigue resistance

- The CarTech® MP35N Alloy exhibits a good impact resistance and ductility in the complete range of the cryogenic temperatures.

- Continuous use from -269°C (liquid helium) to max 400°C

- The CarTech® MP35N Alloy is nobler than the 1.4435 (316L) or inferior stainless steels. Its assembly with such metals may form a galvanic cell leading to the corrosion of the less corrosion resistance metals.

- The CarTech® MP35N Alloy is paramagnetic.

Low temperatures

- Continuous use from -269°C (liquid helium) to max 400°C

Galvanic corrosion

- The CarTech® MP35N Alloy is nobler than the 1.4435 (316L) or inferior stainless steels. Its assembly with such metals may form a galvanic cell leading to the corrosion of the less corrosion resistance metals.

Magnetism

- The CarTech® MP35N Alloy is paramagnetic.
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Magnetic permeability

- The magnetic relative permeability is <1.0010 of the CarTech® MP35N Alloy is most favorable. It permits to obviate the danger of implants or components displacements in the strong magnetic fields of up to 6-8 T encountered in the last generation of scanners for magnetic resonance imaging.

Passivation

- The CarTech® MP35N Alloy can be passivized. Passivation treatment: nitric acid 40% / room temperature

Tribological properties

- The fretting resistance of the CarTech® MP35N Alloy improves with the cold deformation rate.

Physical properties

<table>
<thead>
<tr>
<th>Properties</th>
<th>Unit</th>
<th>Temperature (°C)</th>
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</thead>
<tbody>
<tr>
<td>Density</td>
<td>g cm⁻³</td>
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<tr>
<td>E Young modulus</td>
<td>m/m⁻¹.K⁻¹</td>
<td>26°C</td>
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<tr>
<td>E modulus annealed</td>
<td>GPa</td>
<td>233</td>
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<tr>
<td>E modulus CW + aging</td>
<td>GPa</td>
<td>219</td>
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<tr>
<td>Shear modulus G</td>
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<td></td>
<td>GPa</td>
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<td></td>
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<td></td>
<td>GPa</td>
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<tr>
<td>Poisson coefficient</td>
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