



**OVAKO**

**HARD CHROME  
PLATED BARS AND TUBES  
CROMAX<sup>®</sup>**





# IDEAL FOR HYDRAULICS

**Cromax bars and tubes from Ovako have become the ideal choice for hydraulic components to a large number of companies worldwide. Ovako's deep metallurgical know-how and extensive R&D has resulted in hard chrome plated products that excel in corrosion resistance and mechanical properties, as well as unmatched quality consistency and professional technical support. Ovako is one of the largest producers of hard-chrome plated bars and tubes in Europe and we run production units in Sweden, Holland, France and Italy.**

For more than 35 years, we have supplied hard-chromed bars and tubes that help companies worldwide to create successful hydraulic applications.

## **Performance you can trust**

Cromax offers strength and other mechanical properties that are superior to competitive products. To further increase impact resistance and buckling strength, as well as minimizing component weight, all Cromax grades can be delivered as induction-hardened.

Ovako is a high quality supplier that controls the entire manufacturing process from raw materials to the final product. The result is products with consistent quality. Together with tests on every batch, this offers excellent reliability and traceability while it also safeguards customer productivity.

## **Three strategies to fight corrosion**

Depending on the environment where the Cromax-based hydraulic component is going to be used, there are different levels of corrosion resistance to meet the challenge.

The standard Cromax product has one chrome layer and subject to a special surface finishing process.

Cromax C has double chrome layers for increased corrosion resistance. Two layers reduce the risk that the external environment can penetrate and attack the underlying steel.

Furthermore, all Cromax grades can be supplied as nickel chrome products (NiKrom™) to meet the needs in aggressively corrosive environments such as marine, offshore mining and many more.

## **Your speaking partner**

As a Cromax customer you have access to extensive service functions such as technical support, customized dimensions, cutting and machining services as well as timely and tailor made delivery solutions.

## **Trusting the Cromax technology**

Ovako's Cromax technology is trusted worldwide by a wide range of companies in industries such as earth moving equipment, materials handling, mining equipment, forestry machinery, agricultural equipment, industrial hydraulics and pneumatics.

# CROMAX 280X

## Hard chrome bar

Cromax 280X is based on a low carbon, microalloyed steel combining high strength with excellent machinability and weldability. For  $\varnothing \leq 90$  mm, yield and tensile strength are 20% higher than normal for hard-chrome bars based on low-carbon weldable steel. This improvement is achieved without detriment to machinability or weldability.

In comparison with standard products based on grade 20MnV6, the superior properties of Cromax 280X offers a number of potential advantages in the design and manufacture of fluid-power cylinders, not the least the possibility to downsize piston rods without loss of load-bearing capacity, thereby reducing not only weight but also cost.

### Average chemical analysis Cromax 280X

| C %  | Si % | Mn % | S %   | V %  | C.E. % (*) |
|------|------|------|-------|------|------------|
| 0.18 | 0.35 | 1.55 | 0.025 | 0.11 | 0.55 max   |

\*C.E. = % C + % Mn/6 + (% Cu + % Ni)/15 + (% Cr + % Mo + % V)/5

### Corresponding standards

The table shows the closest equivalent standard for the steel in Cromax 280X.

| Ovako grade | EN     | DIN    | BS  | AFNOR | ASTM |
|-------------|--------|--------|-----|-------|------|
| Ovako 280X  | 20MnV6 | 20MnV6 | 55M | E420  | A572 |

### Mechanical properties

| Size ( $\varnothing$ ) | Yield stress<br>$R_{eHr}$ N/mm <sup>2</sup> ,<br>min | Ultimate<br>tensile stress<br>$R_{eHr}$ N/mm <sup>2</sup> | Elongation<br>$A_5$ , %, min | Hardness<br>HB | Toughness<br>KV, Joule, min |
|------------------------|--|---|------------------------------|----------------|-----------------------------|
| <20                    | 520  | 650–800   | 12                           | 200–240        | No guarantee                |
| 20-90                  | 520  | 650–800   | 19                           | 200–240        | 27 at -20 °C                |
| >90                    | 440  | 550–700   | 19                           | 180–230        | No guarantee (*)            |

\*Base steel meeting KV $\geq$ 27J at -20°C can be supplied by special arrangement.

### Chrome layer

For  $\varnothing \leq 20$  mm, the chrome layer thickness is 20  $\mu$ m min.  
For smaller sizes, the minimum thickness is 15  $\mu$ m.

### Surface roughness

The surface roughness (Ra) is always less than 0.2  $\mu$ m and normally in the range 0.05–0.10  $\mu$ m. Rt (ISO) is always less than 2.0  $\mu$ m and normally in the range 0.5–1.0  $\mu$ m.

### Surface hardness

The chrome layer hardness is 850 HV<sub>0.1</sub> min.

### Straightness

For  $\varnothing < 30$  mm, the maximum deviation is 0.1 mm/0.5 m.  
The maximum deviation for larger diameters is 0.1 mm/1.0 m.

### Roundness

The out of roundness is maximised at 50 % of the diameter tolerance interval.

### Diameter tolerance

ISO f7 is standard. Other tolerances can be supplied upon request (narrowest range is ISO level 7).



# CROMAX IH 280 X

## Induction-hardened, hard chrome bar

Cromax IH 280X is a surface-hardened version of Cromax 280X and is based on a low carbon, micro-alloyed steel combining high strength with excellent machinability and weldability. For  $\varnothing \leq 90$  mm, yield and tensile strength are 20 % higher than for conventional low-carbon weldable steel of 20MnV6-type. This improvement is achieved without detriment to machinability or weldability. In comparison with standard hard-chrome bar based on non-hardened 20MnV6, Cromax IH 280X offers the following advantages:

- Improved resistance to external impact during rod manufacture and service
- Increased resistance to buckling failure giving opportunities to reduce weight and cost
- Greater compressive strength

Cromax IH 280X also brings a range of advantages when compared with conventional induction-hardened rod based on medium-carbon steel such as C45E, 39MnV6 or 42CrMo4:

- Elimination of risk for catastrophic failure in rods subjected to side loading (bending forces)
- Better ductility and toughness in both the base steel and the hardened layer
- Improved weldability (normally no need to preheat)
- Easier to machine both the hardened layer and the base steel
- Can be cut to length with a regular high-speed steel saw blade (no need for abrasive wheels or carbide-tipped blades)

### Average chemical analysis Cromax IH 280X

| C %  | Si % | Mn % | S %   | V %  | C.E. % (*) |
|------|------|------|-------|------|------------|
| 0.18 | 0.35 | 1.55 | 0.025 | 0.11 | 0.55 max   |

\*C.E. = % C + % Mn/6 + (% Cu + % Ni)/15 + (% Cr + % Mo + % V)/5

### Mechanical properties

| Size (Ø) | Yield stress<br>$R_{eHr}$ N/mm <sup>2</sup> ,<br>min | Ultimate<br>tensile stress<br>$R_{eHr}$ N/mm <sup>2</sup> | Elongation<br>$A_{5r}$ %, min | Hardness<br>HB | Toughness<br>KV, Joule, min |
|----------|--|---|-------------------------------|----------------|-----------------------------|
| 20–90    | 550  | 650-800   | 19                            | 200–240        | 27 at –20 °C                |
| > 90     | 440  | 600-750   | 19                            | 180–230        | No guarantee (*)            |

\*Base steel meeting KV $\geq$ 27J at –20°C can be supplied by special arrangement.

### Chrome layer

The thickness of the chrome layer is 20µm min.

### Surface roughness

The surface roughness (Ra) is always less than 0.2 µm and normally in the range 0.05–0.10 µm. Rt (ISO) is always less than 2.0 µm and normally in the range 0.5–1.0 µm.

### Surface hardness

The chrome layer hardness is 850 HV<sub>0.1</sub> min. The hardness in the induction hardened zone immediately beneath the chrome layer is 45 HRC min. and normally in the range 47–50 HRC. The depth of hardening, which is defined as the distance from steel/chrome interface at which the hardness has dropped to 400 HV<sub>5r</sub>, is 1.0–5.0 mm and depends on diameter as tabulated below:

| Size, Ø mm  | Hardening depth, mm |
|-------------|---------------------|
| < 40        | 1.0–2.5             |
| 40 < = < 90 | 1.0–3.0             |
| = > 90      | 1.0–5.0             |

Other hardening depths can be supplied by special arrangement.

### Straightness

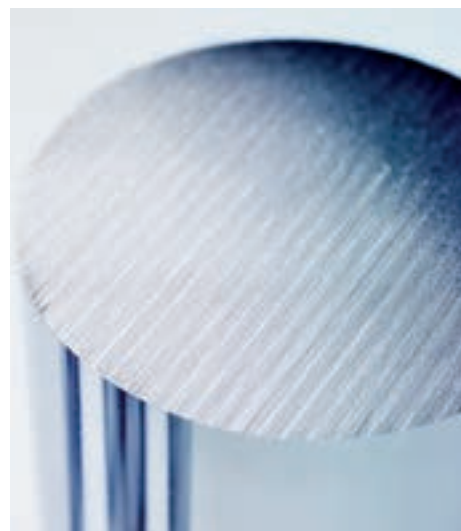
The maximum deviation is 0.1 mm/1.0 m.

### Roundness

The out of roundness is maximised at 50 % of the diameter tolerance interval.

### Diameter tolerance

ISO f7 is standard. Other tolerances can be supplied upon request (narrowest range is ISO level 7).



# CROMAX TUBE

## Hard chrome-plated tube

The starting material for Cromax TUBE is either hot-finished or cold-drawn tube in a microalloyed, low-carbon weldable steel of 20MnV6-type. Cromax Tube exhibits a good combination of strength and toughness along with excellent machinability and weldability.

### Average chemical analysis Cromax TUBE

| C %  | Si % | Mn % | S %  | V %  | C.E. % (*) |
|------|------|------|------|------|------------|
| 0.19 | 0.35 | 1.50 | 0.02 | 0.11 | 0.55 max.  |

\*C.E. = % C + % Mn / 6 + ( % Cu + % Ni ) / 15 + ( % Cr + % Mo + % V ) / 5

### Corresponding standards

The table shows the closest equivalent standard for the steel in Cromax TUBE.

| Cromax | EN     | DIN    | BS  | AFNOR | ASTM |
|--------|--------|--------|-----|-------|------|
| TUBE   | 20MnV6 | 20MnV6 | 55M | E420  | A572 |

### Mechanical properties

| Yield stress<br>$R_{eH}$ , N/mm <sup>2</sup> ,<br>min | Ultimate<br>tensile stress<br>$R_{eH}$ , N/mm <sup>2</sup> | Elongation<br>$A_5$ , %, min | Hardness<br>HB | Toughness<br>KV, Joule, min |
|---|--|------------------------------|----------------|-----------------------------|
| 450   | 550-800  | 20                           | 160-240        | 27 at -20°C                 |

### Chrome layer

The chrome layer thickness is 20 µm min.

### Surface roughness

The surface roughness (Ra) is always less than 0.2 µm and normally in the range 0.05–0.10 µm. Rt (ISO) is always less than 2.0 µm and normally in the range 0.5-1.0 µm.

### Surface hardness

The chrome layer hardness is 850 HV<sub>0.1</sub> min.

### Straightness

The maximum deviation is 0.3 mm/1.0 m.

### OD roundness

The out of roundness is maximised at 50 % of the diameter tolerance interval.

### OD tolerance

ISO f8 or f7 is standard. Other tolerances can be supplied upon request (narrowest range is ISO level 7).

### ID tolerance

This is determined by the tolerances for OD and wall thickness.

### Wall tolerances

No guarantee can be given with respect to eccentricity or wall thickness tolerance. Typical levels are ±5 % for wall thickness and ±10 % (of average wall thickness) for eccentricity.



# CROMAX IH 482

## Induction-hardened, hard chrome bar

Induction-hardened Cromax IH 482 is based on a medium carbon, micro-alloyed steel, which is characterised by high strength in the as-rolled condition, i.e. without heat treatment. The 482 base steel is a cost-effective alternative to traditional low-alloy, quenched and tempered grades with, in the context of piston-rod applications, equivalent properties.

The analysis of the base steel in Cromax IH 482 is well adapted to induction hardening and a high and uniform hardness is achieved throughout the case irrespective of diameter. In consequence, the resistance to even high-energy external impact is excellent.

### Average chemical analysis Cromax IH 482

| C %  | Si % | Mn % | S %  | V %  | C.E. % (*) |
|------|------|------|------|------|------------|
| 0.39 | 0.40 | 1.20 | 0.02 | 0.13 | max 0.72   |

\*C.E. = % C + % Mn/6 + (% Cu + % Ni)/15 + (% Cr + % Mo + % V)/5

### Corresponding standards

The table shows the closest equivalent standard for the steel in Cromax IH 482. In most cases, the correspondence is only approximate.

| Cromax | EN      | DIN       | AFNOR | SAE/ASTM |
|--------|---------|-----------|-------|----------|
| 482    | 38MnVS6 | 38MnSiV55 | 30MV6 | 1045V    |

### Mechanical properties

| Yield stress<br>$R_{eHr}$ , N/mm <sup>2</sup> ,<br>min | Ultimate<br>tensile stress<br>$R_{eHr}$ , N/mm <sup>2</sup> | Elongation<br>$A_5$ , %, min | Hardness<br>HB | Toughness<br>KV, Joule, min                      |
|--|---|------------------------------|----------------|--|
| 580  | 850–1000  | 14                           | 250–300        | No guarantee given, but normally 15–30 J at 20°C |

### Chrome layer

The thickness of the chrome layer is 20µm min.

### Surface roughness

The surface roughness (Ra) is always less than 0.2 µm and normally in the range 0.05–0.10 µm. Rt (ISO) is always less than 2.0 µm and normally in the range 0.5–1.0 µm.

### Surface hardness

The chrome layer hardness is 850 HV<sub>0.1</sub> min. The surface hardness in the induction-hardened zone immediately beneath the chrome layer is 55 HRC min. The depth of hardening, which is defined as the distance from the steel/chrome interface at which the hardness has dropped to 400 HV<sub>5r</sub>, is dependent on diameter as tabulated below:

| Size, Ø mm | Hardening depth, mm |
|------------|---------------------|
| < 40       | 1.0–2.5             |
| 40 ≤ < 90  | 1.0–3.0             |
| ≥ 90       | 1.0–5.0             |

Other hardening depths can be supplied by special arrangement.

### Straightness

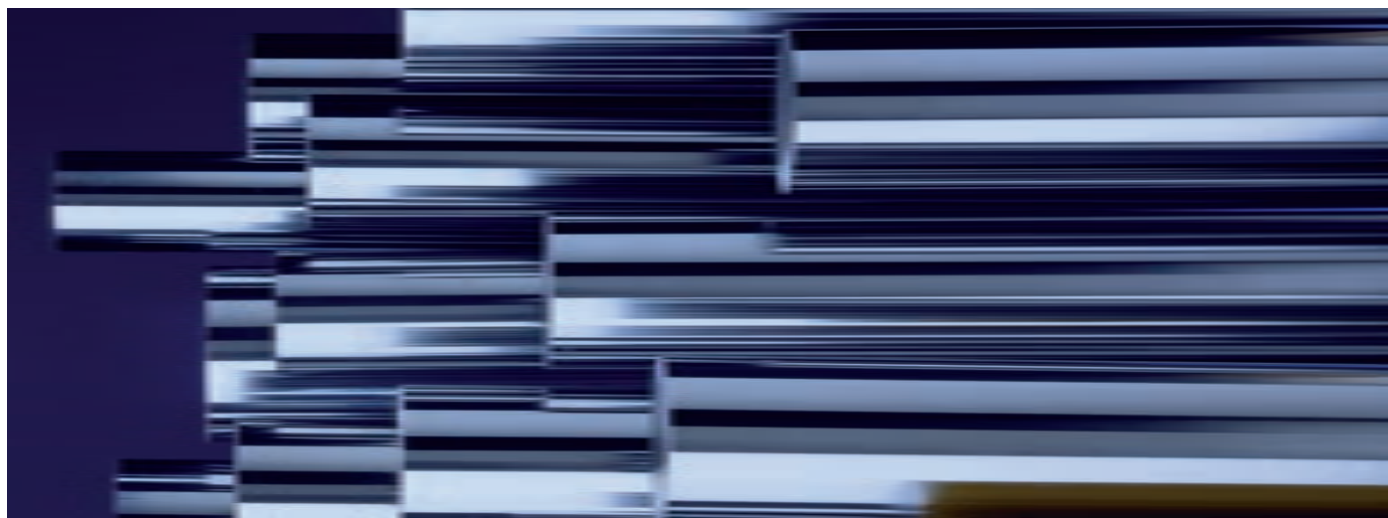
The maximum deviation is 0.2 mm/1.0 m.

### Roundness

The out of roundness is maximised at 50 % of the diameter tolerance interval.

### Diameter tolerance

ISO f7 is standard. Other tolerances can be supplied upon request (narrowest range is ISO level 7).





# CROMAX C AND NI-CROMAX

## Ready-to-use bars

Depending on the environment where the Cromax-based hydraulic component is going to be used, then there are different levels of corrosion resistance to meet the challenge. The standard Cromax products as indicated in the brochure have one chrome layer and are delivered wax polished.

To enhance Corrosion resistance in more demanding and aggressive environments, Cromax C and Ni-Cromax should be used. Cromax C and Ni-Cromax can be produced in all the Cromax grades.

### Cromax C

Cromax C has double chrome layers for increased corrosion resistance. Two layers reduce the risk that the external environment can penetrate and attack the underlying steel. Cromax C guarantees AASS 100 hrs rating 9.

### Ni-Cromax

Ni-Cromax is recommended for hydraulic applications where the cylinders are exposed to continuous exposure of the piston rods and where there is an aggressive environment such as high salinity, high humidity, and a polluted atmosphere. It also ensures the long-term function of piston rods which remain extended for long periods of time, even when the environment is only moderately aggressive. In for example civil engineering, power generation and military applications.

Ni-Cromax with layers 30  $\mu\text{m}$  Nickel and 20  $\mu\text{m}$  std chrome guarantees AASS 500 Hrs rating 10. For lesser aggressive atmospheres and with layers 10  $\mu\text{m}$  Nickel and 20  $\mu\text{m}$  std chrome, the Ni-Cromax guarantees AASS 150 hrs rating 10.

### Surface roughness

The surface roughness (Ra) is always less than 0.2  $\mu\text{m}$  and normally in the range 0.05–0.10  $\mu\text{m}$ . Rt (ISO) is always less than 2.0  $\mu\text{m}$  and normally in the range 0.5–1.0  $\mu\text{m}$ .

### Surface hardness

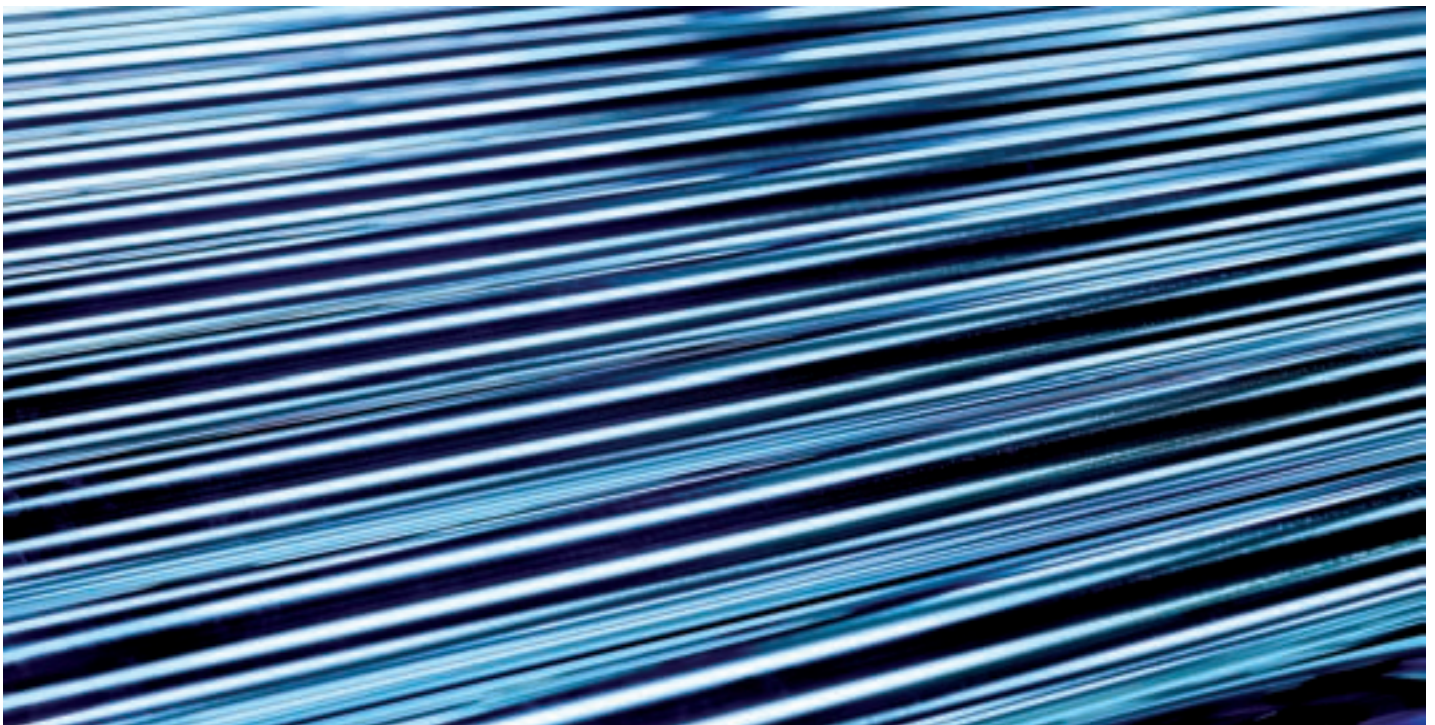
The chrome layer hardness is 850 HV0.1min. The hardness of the nickel layer is about 300 HV0.1.

### Roundness

The out of roundness is maximised at 50 % of the diameter tolerance interval.

### Diameter tolerance

ISO f7 is standard. Other tolerances can be supplied on request (narrowest range is ISO level 7).





# CROMAX C35E

## Hard chrome bar

Cromax C35E is a hard-chrome plated product based on medium-carbon steel. Compared with the traditional C45E-base, C35E offers improved weldability. However, by means of thermo-mechanical processing, the mechanical properties of the C35E used for Cromax products are rendered equivalent to those attainable in C45E.

### Average chemical analysis Cromax C35E (\*)

| C %  | Si % | Mn % | S %  | C.E. % (*) |
|------|------|------|------|------------|
| 0.37 | 0.25 | 0.65 | 0.02 | 0.65 max.  |

\*Analysis spread corresponds to HH requirements in EN 10083-1+A1.

\*\*C.E. = % C + % Mn/6 + (% Cu + % Ni)/15 + (% Cr + % Mo + % V)/5

### Corresponding standards

The table shows the closest equivalent standard for the steel in Cromax C35E.

| Cromax | EN   | DIN  | BS     | AFNOR | SAE/ASTM |
|--------|------|------|--------|-------|----------|
| C35E   | C35E | Ck35 | 080M36 | XC38  | 1035     |

### Mechanical properties

| Size (Ø) | Yield stress<br>$R_{eHr}$ N/mm <sup>2</sup> ,<br>min | Ultimate<br>tensile stress<br>$R_{eHr}$ N/mm <sup>2</sup> | Elongation<br>$A_{5r}$ %, min | Hardness<br>HB |
|----------|--|---|-------------------------------|----------------|
| < 20     | 345  | 590   | 10                            | –              |
| 20 - 90  | 345  | 590   | 19                            | 165–220        |

\*Base steel meeting KV≥27J at –20°C can be supplied by special arrangement.

### Chrome layer

For  $\varnothing \leq 20$  mm, the chrome layer thickness is min. 20  $\mu\text{m}$ .  
For smaller sizes, the minimum thickness is 15  $\mu\text{m}$ .

### Surface roughness

The surface roughness (Ra) is always less than 0.2  $\mu\text{m}$  and normally in the range 0.05–0.10  $\mu\text{m}$ . Rt (ISO) is always less than 2.0  $\mu\text{m}$  and normally in the range 0.5–1.0  $\mu\text{m}$ .

### Surface hardness, induction hardening

The chrome layer hardness is 850 HV<sub>0.1</sub> min. Cromax C35E can be supplied in an induction-hardened execution. In such a case, the hardness immediately beneath the chrome layer is 50 HRC min., and the depth of hardening is between 1.0 and 5.0 mm depending on dimension.

### Straightness

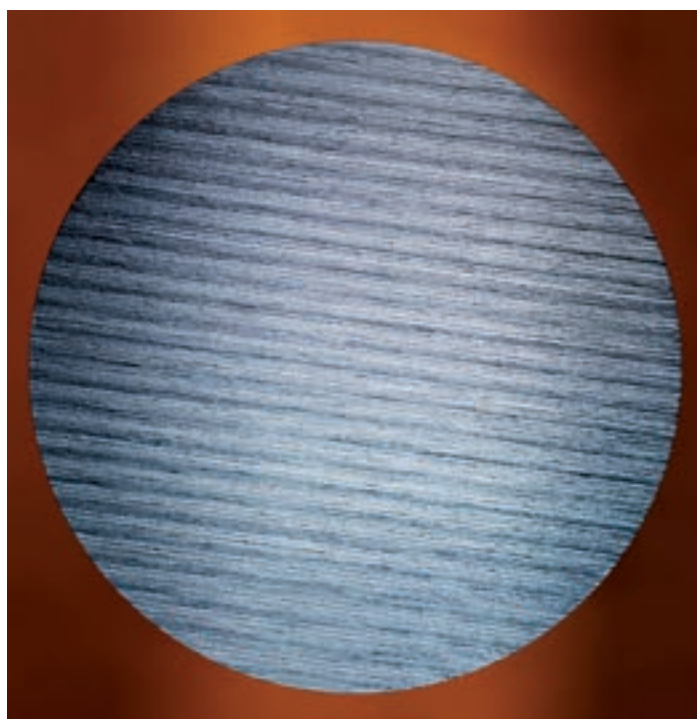
For  $\varnothing < 30$  mm, the maximum deviation is 0.1 mm/0.5 m. The maximum deviation for larger diameters is 0.1 mm/1.0 m.

### Roundness

The out of roundness is maximised at 50 % of the diameter tolerance interval.

### Diameter tolerance

ISO f7 is standard. Other tolerances can be supplied on request (narrowest range is ISO level 7).



# CROMAX 42CRMO4

## Quenched-and-tempered, hard-chrome bar

Quenched-and-tempered Cromax 42CrMo4 is manufactured from the standard low-alloy chromium-molybdenum steel. The product suits application where there is a requirement for elevated strength in combination with a defined and high level of toughness.

### Average chemical analysis Cromax 42CrMo4

| C %  | Si % | Mn % | S %  | Cr % | Mo % |
|------|------|------|------|------|------|
| 0.42 | 0.25 | 0.80 | 0.02 | 1.05 | 0.20 |

### Corresponding standards

The table shows the closest equivalent standard for the steel in Cromax 42CrMo4.

| Cromax  | EN         | DIN      | BS     | AFNOR | ASTM |
|---------|------------|----------|--------|-------|------|
| 42CrMo4 | 42CrMo4+QT | 42CrMo4V | 708M40 | 42CD4 | 4140 |

### Mechanical properties

Quenched and tempered in accordance with EN 10083-1 + A1. Other heat-treatment conditions can be supplied by special arrangement.

| Size (Ø) | Yield stress<br>$R_{eHr}$ N/mm <sup>2</sup> ,<br>min | Ultimate<br>tensile stress<br>$R_{eHr}$ N/mm <sup>2</sup> | Elongation<br>$A_{5r}$ %, min | Hardness<br>HB | Toughness<br>KV, Joule, min |
|----------|--|---|-------------------------------|----------------|-----------------------------|
| < 40     | 750  | 1000–1200   | 11                            | 295–355        | 35 at 20°C                  |
| 40–95    | 650  | 900–1100  | 12                            | 235–295        | 35 at 20°C                  |
| > 95     | 550  | 800–950   | 13                            | 235–295        | 35 at 20°C                  |

### Chrome layer

The thickness of the chrome layer is minimum 20 µm.

### Surface roughness

The surface roughness (Ra) is always less than 0.2 µm and normally in the range 0.05–0.10 µm. Rt (ISO) is always less than 2.0 µm and normally in the range 0.5–1.0 µm.

### Surface hardness, induction hardening

The chrome layer hardness is 850 HV<sub>0.1</sub>. Cromax 42CrMo4 can be supplied in an induction-hardened execution. In such a case, the hardness immediately beneath the chrome layer is 55 HRC min., and the depth of hardening is between 1.0 and 5.0 mm depending on dimension.

### Straightness

The maximum deviation is 0.2 mm/1.0 m.

### Roundness

The out of roundness is maximised at 50 % of the diameter tolerance interval.

### Diameter tolerance

ISO f7 is standard. Other tolerances can be supplied upon request (narrowest range is ISO level 7).



# COMMON CROMAX FACTS

The standard dimension range for Ovako Cromax products are from 10 mm to 150 mm and in principle most grades and sizes are kept in stock.

Our stock standard lengths are predominantly 6.1 m -0, +100 mm. Shorter and longer lengths can be produced upon request.

In addition we have a substantial cutting capacity to cut lengths of all diameters with a cut length tolerance of -0, +2 mm.

## Packaging

Cromax bars and tubes are supplied as standard in plastic sleeves and can upon request be delivered with cardboard tubes. The materials are then packed according to the transport and destination conditions for the product.

## Corrosion resistance

Ovako's Cromax products are characterized by a controlled micro-crack distribution with high crack density, which in combination with specially adapted finishing procedures, provides for superior corrosion resistance. Most corrosion resistance specifications for hard-chrome products are based on salt-spray testing following the ISO 9227 standard or its equivalents (see below), combined with evaluation according to ISO 10289.

| ISO 9227 | ASTM  | DIN 50021 | Salt spray type                |
|----------|-------|-----------|--------------------------------|
| NSS      | B 117 | SS        | Neutral                        |
| AASS     | B 287 | ESS       | Acetic acid                    |
| CASS     | B 368 | CASS      | Copper-accelerated acetic acid |

While the correlation between these methods is not always clear, our experience is that a given degree of corrosion is reached 2-3 times as fast in the AASS test as in NSS-testing.

The following corrosion resistance is reached on Ovako Cromax hard chromed bars and tubes:

|               |                        |
|---------------|------------------------|
| Std Chrome*   | AASS 40 Hrs rating 9   |
| Cromax C*     | AASS 100 Hrs rating 9  |
| Ni-Cromax 150 | AASS 150 Hrs rating 10 |
| Ni-Cromax 350 | AASS 500 Hrs rating 10 |

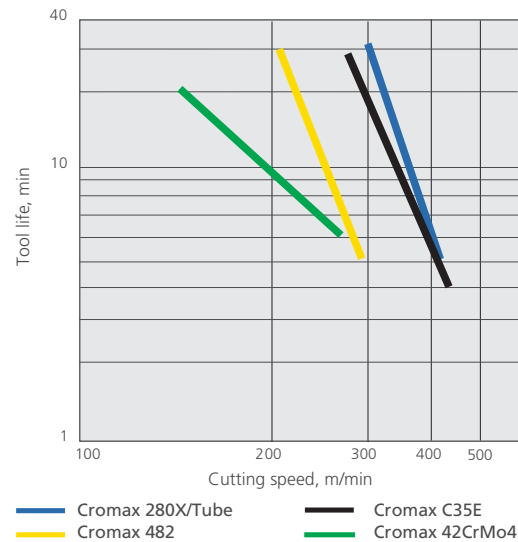
\*Higher values for customer specific requirements can be achieved upon request

*We reserve the right to make changes to dimensions, tolerances and other data given in this sheet.*

*Liability disclaimer. All statements and implications regarding the properties or fitness for purpose of the products described in this sheet are for information only. Guarantees in relation to specific properties or fitness for purpose are valid only if agreed upon in writing.*

## Machinability

The machinability of Cromax products in turning is compared in the diagram below. Coated carbide tool Sandvik SNMG 120408-PM-4015. Feed 0.4 mm/r. Cutting depth 2 mm. Wear criterion 0.4 mm. Cutting fluid: Peralube 0125 5 %.



## Weldability

All Ovako Cromax Grades are suitable for welding and some recommendations are to be followed on certain materials. Please contact us if more information is required





## About Ovako

Ovako develops high-tech steel solutions for, and in cooperation with, its customers in the bearing, transport and manufacturing industries. Our steel makes our customers' end products more resilient and extends their useful life, ultimately resulting in smarter, more energy-efficient and more environmentally-friendly products.

Our production is based on recycled scrap and includes steel in the form of bar, tube, ring and pre-components. Ovako is represented in more than 30 countries, and has sales offices in Europe, North America and Asia. Ovako's sales in 2014 amounted to EUR 862 million, and the company had 2,925 employees at year-end. For more information, please visit us at [www.ovako.com](http://www.ovako.com)



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