TG Steels

# 2311 PRIME

# Prehardened mold steel with good machinability suitable for general applications with good polishability and texturing

2311 PRIME;

- is produced by a process that ensures a good level of cleanliness and homogeneity.
- has an good toughness better than 2312 PRIME and it can be also used for mechanical applications.
- has a good polishability, is good for texturing, better than 2312 PRIME.
- can also be welded and exhibits a good machinability but still lower than 2312 PRIME.
- is delivered at a hardness of 300 HB and can be machined without further heat treatment.
- has a very good suitability for surface treatments such as gas, ionic or salt bath nitriding, as well as PVD or CVD coatings.

## Applications

2311 PRIME can be used for small sizes to very large injection molds requiring good polishability and good texturing level.

2311 PRIME can also be used for molds for abrasive polymers and reinforced plastics.

2311 PRIME can be used for all the secondary parts in molding applications and also frames for plastic molds.

2311 PRIME can also be used for mechanical applications requiring a hardness around 300 HB associated with a good toughness.

2311 PRIME can also be used for pressure casting dies, recipient sleeves.

## Main properties

- Prehardened steel at 300 HB ready to be machined without any further heat treatment
- Good polishability and good texturing
- Good toughness
- Good machinability
- Suitable for surface treatments

## Chemical composition *(typical)*

| C | Mn | Si | P | S | Cr | Mo |
|---|---|---|---|---|---|---|
| 0.40 | 1.45 | 0.30 | < 0.035 | < 0.035 | 1.95 | 0.20 |

## Designation

| Werkstoff Nr | ISO | China GB | JIS Japan | UK | AISI USA | Russia Gost | AFNOR | Other / Special |
|---|---|---|---|---|---|---|---|---|
| 1.2311 | 40CrMnMo7 | 3Cr2Mo | - | - | ≈ P20 | 40KHGM | 40CMD8 | - |

## Structure

The structure of the 2311 PRIME is fine and homogeneous without precipitation or alignments of carbides. The heat treatment *(quench and tempering)* is optimized for high homogeneity of hardness from surface to core even for thicker blocks.

## Hardness at the time of delivery

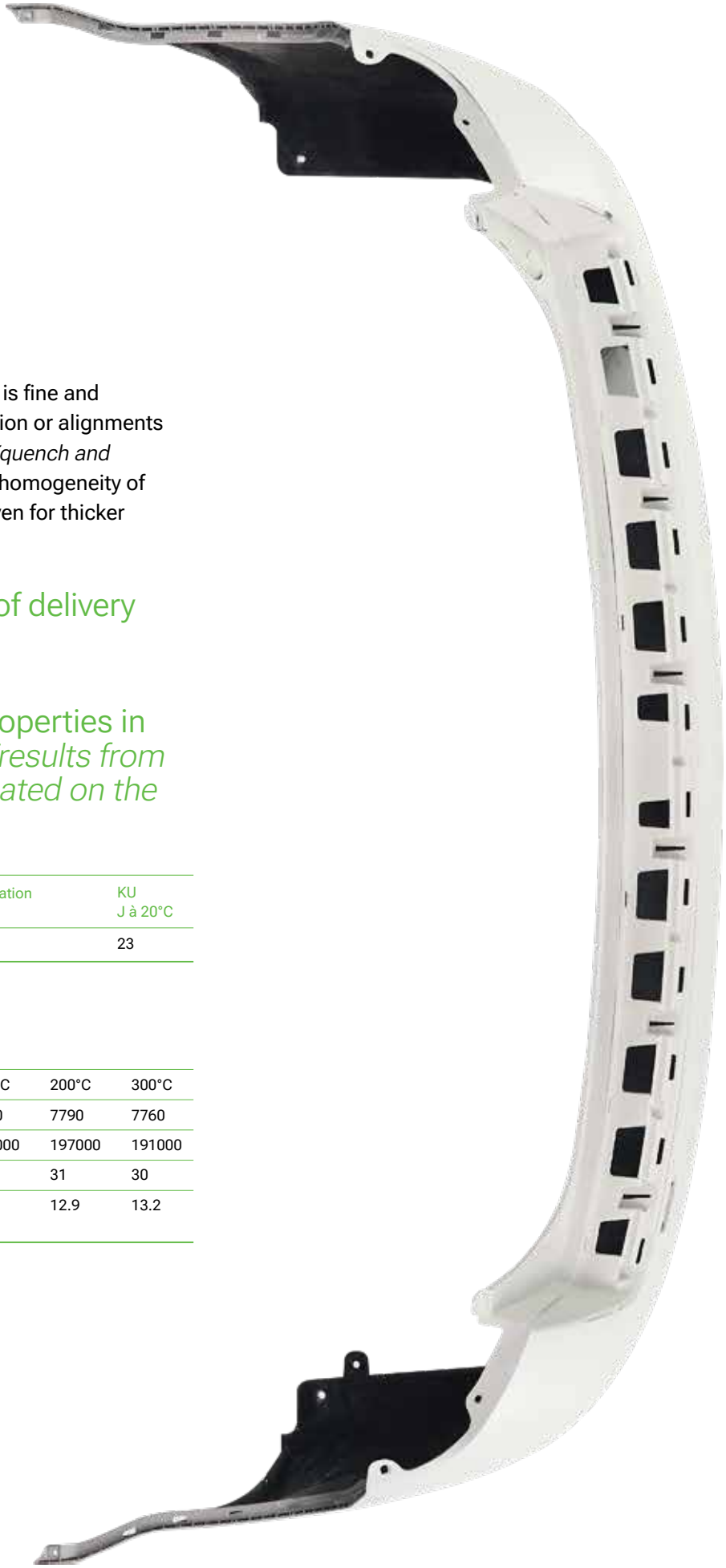
Heat treated for 280 - 340 HB

## Typical mechanical properties in hardened conditions *(results from internal tests not indicated on the certificates)*

| TS<br>MPa | YS 0.2%<br>MPa | Elongation<br>% | KU<br>J à 20°C |
|---|---|---|---|
| 950 | 860 | 11 | 23 |

## Physical properties

| Temperature | 20°C | 100°C | 200°C | 300°C |
|---|---|---|---|---|
| Volumic mass kg/m$^3$ | 7850 | 7820 | 7790 | 7760 |
| Young Modulus N/mm² | 210000 | 205000 | 197000 | 191000 |
| Thermal conductivity W/m.K | 34 | 33 | 31 | 30 |
| Coefficient of linear expansion 10$^{-6}$/K | 11.5 | 11.6 | 12.9 | 13.2 |



## Heat treatment

**The 2312 PRIME is delivered heat treated at 280 - 340 HB and there is no need for further heat treatment.**

In case of need *(e.g. if other mechanical properties are required)* the following parameters can be used.

### SOFT ANNEALING

Temperature: 710 - 730°C, duration 1h + 1h for 25 mm thickness. slow cooling in the furnace *(10 to 20°C/h)*. The atmosphere in the furnace must be reducing to avoid decarburization of the steel.

### STRESS RELIEVING

After machining, it is recommended to perform stress relieving at 550°C maximum for a minimum of 2 hours, followed by slow cooling in the furnace to 450°C.

### AUSTENITIZATION

In order to avoid any risk of cracking it is recommended to preheat in 2 steps.

- 1st preheating step: temperature: 450°C time: 30 s/mm of thickness
- 2nd preheating step: temperature: 650°C time: 30 s/mm of thickness

Recommended austenitizing temperature: 850 - 870°C. The holding time should not be too long to avoid a risk of grain coarsening and a loss of toughness. It is recommended to keep the part at the austenitizing temperature 30 minutes per inch of thickness as soon as the temperature of the surface reach the austenitization temperature.

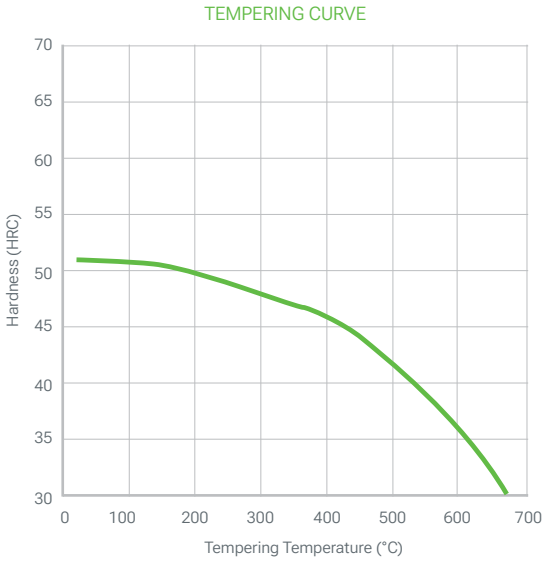
### QUENCHING MEDIUM

Oil at 80°C, vacuum *(pressure >6 bars)*, salt bath 500 - 550°C.
To ensure good toughness, treatment with oil or salt bath is preferable.

### TEMPERING

To ensure a minimum residual austenite rate as well as greater tool stability, it is essential to perform a double tempering. Each tempering is followed by a cooling under 100°C.

Each tempering time must be at least equal to 1h + 1h for 25 mm of thickness of the treated part *(equivalent thermal thickness).*




## Surface treatment

### NITRIDING

2311 PRIME can be nitrided at temperatures less than or equal to 20°C below tempering temperatures without risk of deterioration of the mechanical characteristics. With a gas nitriding at 520°C *(25 h)* the surface hardness is 750 HV1 with a diffusion layer of 0.2 mm.

### PVD, CVD

2311 PRIME is suitable for all kinds of PVD and CVD treatment as soon as the treatment temperature is 30°C lower than the last tempering temperature.

## Polishing

2311 PRIME is perfectly suitable for polishing in the treated state and can be used for applications requiring a sufficient level of polish for translucent - transparent parts *(Rt ≤ 20 µm, CNOMO level 2, Rugotest N7).*

Optimal polishing is achieved by performing consecutive steps with similar roughness and stopping each step as soon as the last scratch from the previous step disappears.

## Texturing

2311 PRIME is suitable for chemical or laser texturing.

## Induction or laser hardening

2311 PRIME can be surface hardened up to 52 - 54 HRC by induction or laser. Please consult us for more details. A stress relieving at 150°C for minimum 2 hours is mandatory after surface hardening.

## Machining

The machining parameters below are given for information only and must be adapted according to the equipment and usual machining conditions.

### TURNING

| | Carbide tool | |
|---|---|---|
| | Rough machining | Finishing |
| Cutting speed m/min | 90 - 120 | 120 - 160 |
| Feed mm/r | 0.15 - 0.35 | 0.05 - 0.2 |
| Depth of cut mm | 2 - 4 | 1 |

### MILLING: SURFACING

| | Milling with carbide tools | | Solid tool |
|---|---|---|---|
| | Rough machining | ½ Finishing | Finishing |
| Cutting speed m/min | 50 - 120 | 110 - 130 | 30 - 60 |
| Feed mm/r | 0.15 - 0.35 | 0.1 - 0.2 | 0.005 - 0.15 |
| Depth of cut mm | 2 - 4 | 2 | |

### DRILLING: HSS TWIST DRILL

| Drill diameter mm | Cutting speed m/min | Feed mm/t |
|---|---|---|
| < 5 | 10 | 0.05 - 0.10 |
| 5 - 10 | 10 | 0.10 - 0.15 |
| 10 - 15 | 10 | 0.18 - 0.25 |
| 15 - 20 | 10 | 0.22 - 0.29 |

### DRILLING: CARBIDE DRILL

| | Carbide type | | |
|---|---|---|---|
| | Indexable insert | Solid carbide | Carbide tip |
| Cutting speed m/min | 150 - 170 | 90 - 120 | 50 - 70 |
| Feed mm/t | 0.05 - 0.10 | 0.10 - 0.25 | 0.15 - 0.25 |

### FINE GRINDING

General indications for grinding wheels to be used on 2311 PRIME in the heat treated condition.

Usually, rather soft vitrified aluminum oxide grinding wheels *(grades G for plane grinding to K for cylindrical grinding)* are used.

Particular attention will be paid to effective cooling of the surface during grinding to prevent degradation of the material surface.

### ELECTRO-DISCHARGE MACHINING

2311 PRIME is also suitable for EDM machining *(wire or electrode)*. Preferably, the machining will be carried out with a low current density and a high frequency in order to limit the thickness of the white layer as much as possible.

Then it is necessary to carry out a stress relieving at 25°C below the last tempering in order to reduce the level of residual stresses *(which could lead to a risk of cracking)* and to carry out a polishing to completely remove the white layer formed during the discharge machining process.

## Welding

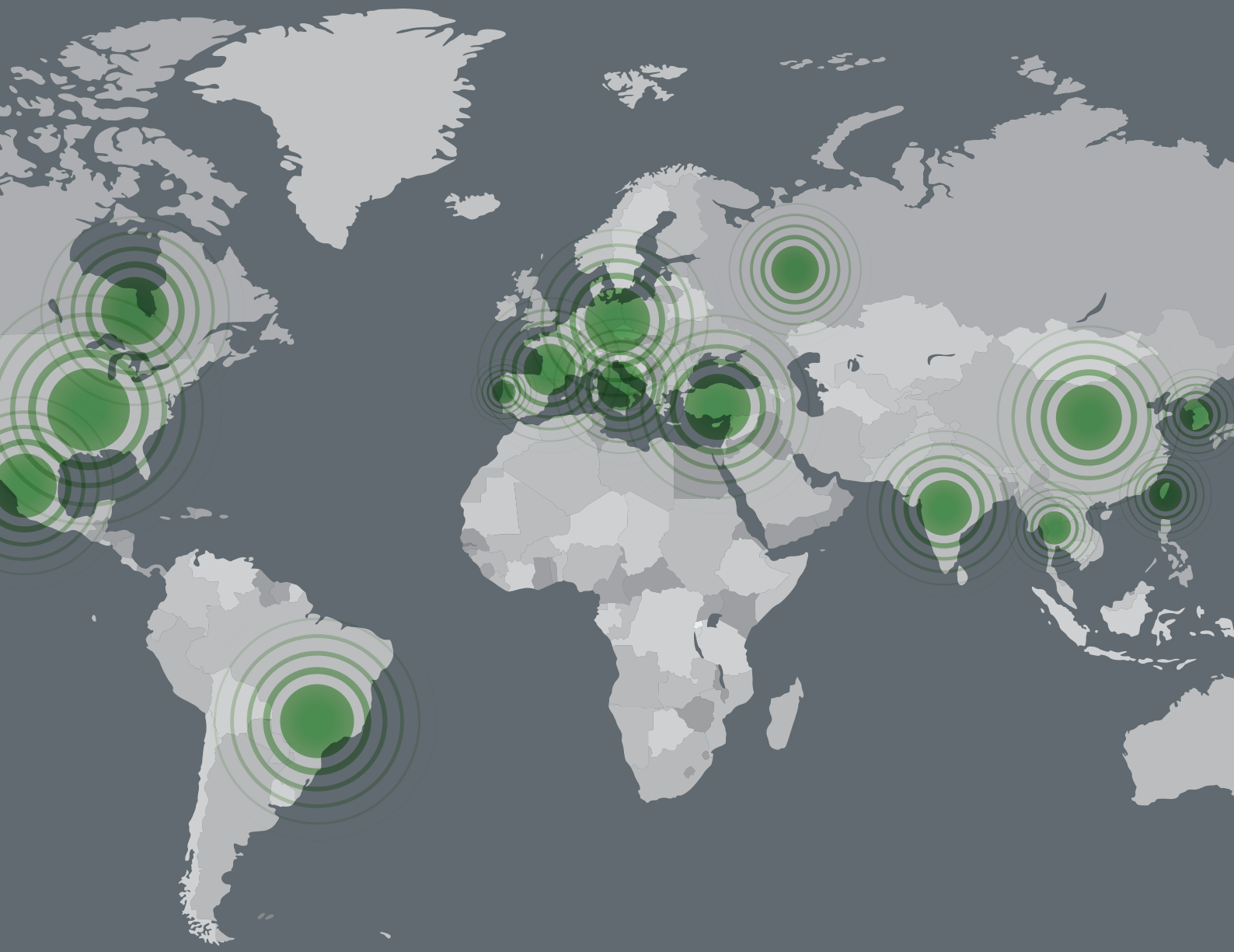
The 2311 PRIME could be welded in the heat treated condition.

- Method: TIG
- Feeder wire: 25CrMo4
- Preheating: 300°C

Hold at 200°C during the welding operation with a maximum interpass temperature at 350°C. Slow cooling (max 20°C/h) after welding.

- Post treatment: At 550°C, duration 1h + 1h for 25 mm of thickness. slow cooling in the furnace (10 to 20°C/h). Hardness of the welded area: ≈300 HB

Depending on the surface *(polished or textured)* the welding conditions can be optimized. Please consult us for more details.



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