# LUCCHINI 2738

## PRE-HARDENED MOULD STEEL WITH AN HIGH DEGREE OF THROUGH HARDENING AND MACHINABILITY

## General characteristics

LUCCHINI 2738 is the special pioneer pre-hardened alloyed steel for moulds with an high degree of through hardening, machinability and polishability.

LUCCHINI 2738 has been developed for large dimension moulds with an high degree of through hardening in the section, thanks to the special calibration of the chemical analysis, particularly due to the adding up to 1.30% Nickel by alloying.

## Delivery conditions

LUCCHINI 2738 is normally supplied in the pre-hardened condition in a wide dimensional range up to 1000 mm in thickness.

The surface hardness is 290-340 HB and the mid-thickness hardness value is guaranteed in section up to 1000 mm, according to the following correlation: $(HB_{Surface,min\ required} - HB_{Core}) \leq 20HB$

## Main features

- excellent machinability;
- very good suitability for photo-engraving;
- very good suitability for polishing;
- excellent suitability for nitriding, in order to increase the wear resistance;
- good wear resistance in the whole section of the mould;
- internal homogeneous hardness on blocks with thickness up to 1000 mm in the whole section of the mould;

## Main application

Plastic moulding:
- medium and big sized moulds for the automotive industry;
- moulds for food industry products;
- moulds for rubber pressing;
- pressure moulds (SMC, BMC);
- bolsters.

Extrusion:
- dies and gauges for PVC extrusion;
- mechanical parts for extrusion presses.

## Chemical analysis

| | Range | C [%] | Si [%] | Mn [%] | Cr [%] | Mo [%] | Ni [%] |
|---|---|---|---|---|---|---|---|
| ***LUCCHINI** 2738* Alloying [% in weight] | min | 0,35 | 0,20 | 1,40 | 1,80 | 0,15 | 0,90 |
| | max | 0,45 | 0,40 | 1,70 | 2,20 | 0,30 | 1,30 |

Comparison with international classifications:
**W. Nr.** 1.2738
**DIN EN ISO 4957** 40CrMnNiMo8.6.4



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## Physical and mechanical properties

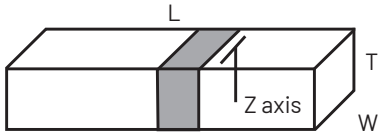
### *Main physical properties*

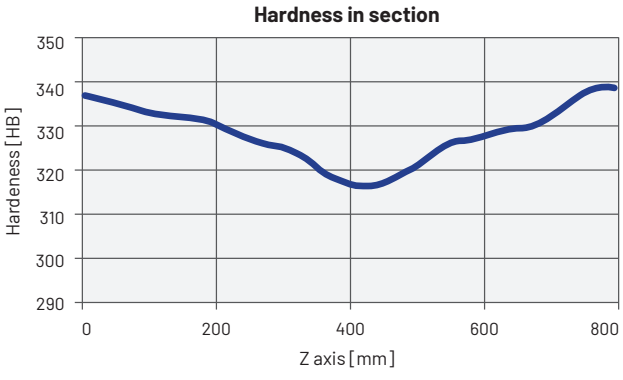
| LUCCHINI 2738 | 20°C | 200°C | 400°C |
|---|---|---|---|
| Young modulus E [MPa] | 210 | 196 | 177 |
| Coefficient of linear thermal expansion α [10-6/K] | - | 12,7 | 14,3 |
| Thermal conductivity λ [W/mK] | 31,0 | 36,8 | 36,8 |

### *Main mechanical properties*

| LUCCHINI 2738 | 20°C | 200°C |
|---|---|---|
| Ultimate tensile strength UTS [MPa] | 1.020 | 900 |
| Yield strength YS [MPa] | 880 | 750 |
| Elongation A [%] | 15 | 17 |
| Reduction in area Z [%] | 48 | 50 |

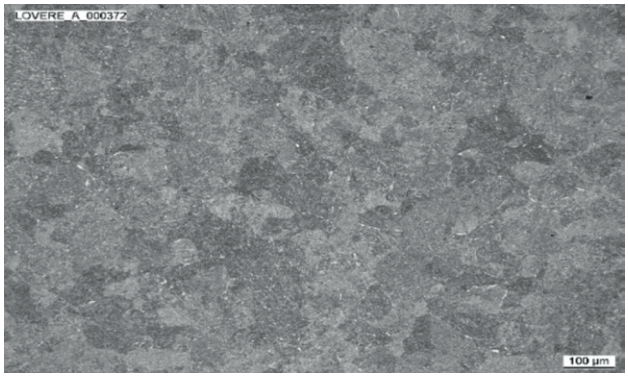
### *Hardness profile*



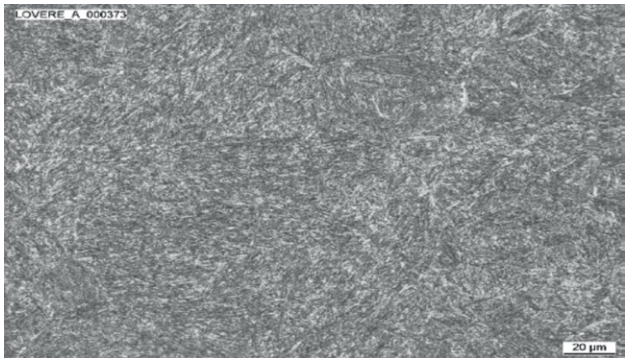




### *Microstructure*

The main microstructure of LUCCHINI 2738 is tempered martensite.

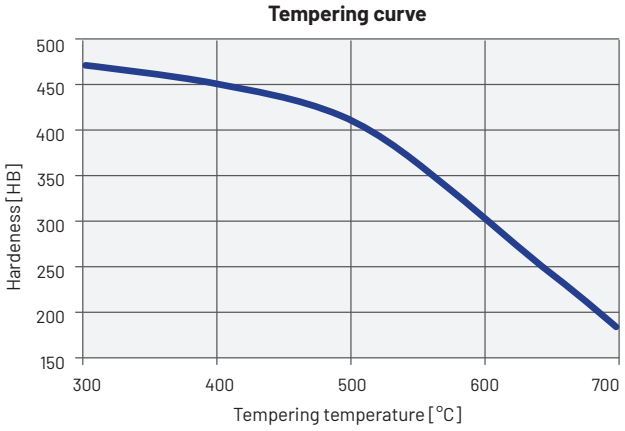



100x




500x

### *Surface hardness vs tempering temperature*




**Remark:** the above data are representative of the typical behaviour of a 800 mm thick block made in LUCCHINI 2738 and are reported for information only



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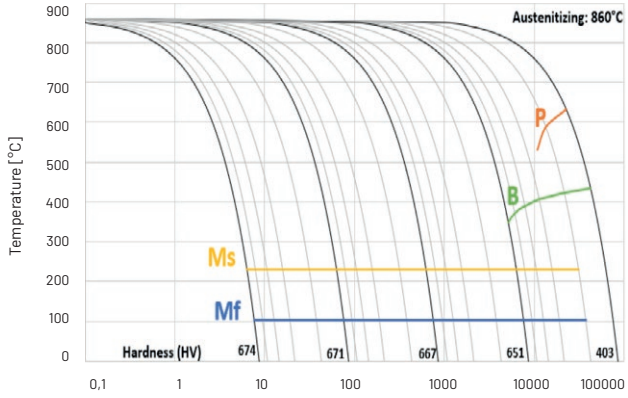
## Heat treatment

LUCCHINI 2738 is supplied in quenched and tempered conditions with no need for additional heat treatment operations.

However, if different hardness/heat treatment procedure are required, we recommend the following parameters.

Note that the reported data are for information purpose only and must be adjusted to the heat treatment facility and the dimensions of the block therefore, before carrying out any heat treatment operation, it is strongly recommended to contact Lucchini RS for help and support.

### *Continuous cooling transformation curve (CCT)*




### *Soft annealing*

| | |
|---|---|
| **Suggested temperature** | 700 °C |
| **Soaking time** | 60 min every 25 mm thickness |
| **Cooling** | Slow cooling in furnace (20°C/h) |

Soft annealing is useful to improve machinability reducing hardness at 250 HB.

### *Stress relieving*

| | |
|---|---|
| **Suggested temperature** | 500 °C |
| **Soaking time** | 60 min every 25 mm thickness |
| **Cooling** | Slow cooling in furnace (20°C/h) |

Stress relieving is recommended to reduce the tensions generated by certain manufacturing operations (e.g. machining) without affecting the hardness in the as-delivered conditions.

If the suggested temperature is lower than the tempering temperature, the stress relieving temperature will be 50° C lower than the tempering temperature previously applied.

### *Hardening*

| | |
|---|---|
| **Suggested temperature** | 860 °C |
| **Soaking time** | 60 min every 25 mm thickness |
| **Cooling** | Room temperature |

### *Tempering*

| | |
|---|---|
| **Suggested temperature** | Depending on the required mechanical properties |
| **Soaking time** | 120 min every 25 mm thickness |
| **Cooling** | Polymer or water quench |

The tempering temperature should be selected form the graph "Tempering curve" reported above.

After tempering we suggest to carry out stress relieving at temperature 50°C lower than the last tempering temperature.



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***Induction hardening***

LUCHINI 2738 is suitable for induction hardening. We recommend cooling at room temperature and tempering after induction hardening.

***Nitriding***

LUCHINI 2738 is suitable for ionic and gas nitriding.

This treatment is very useful for moulds or dies subjected to extremely stressful applications.

The increase of the surface hardness, following nitriding, lengthens the component life cycle.

Modern nitriding processes allow the original dimensions of the component to be maintained.

We recommend heat treating the component in the finish machined condition.

We recommend the following manufacturing cycle, in order to obtain the best results:

- rough machining;
- stress relieving;
- finish machining;
- nitriding.

Other properties can be deeper analysed against specific Customer request: please contact our Metallurgy Department.

## Polishing and photo-engraving

LUCCHINI 2738 is the suitable material when polishing and photoengraving are needed. Thanks to its integrated manufacturing process, those material manufactured by Lucchini RS are characterized by a high degree of purity.

**Polishing for graining:** 3 Very good
**Suitability for medium gloss polishing:** 3 Very good
**Suitability for mirror polishing:** 2 Good
**Suitability for engraving:** 3 Very good

Rating scale:
**4 Excellent – 3 Very good – 2 Good – 1 Normal – 0 Unsuitable**



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## Guidance for machining

The following parameters are approximate only and must be adjusted to the specific application and machine tool.

### *Turning*

| | Rough machining | Finish machining | | |
|---|---|---|---|---|
| Type of insert | P20-P40 coated | HSS | P10-P20 coated | Cermet |
| $V_c$ cutting speed [m/min] | 150 ÷ 190 | (*) | 190 ÷ 230 | 260 ÷ 320 |
| $a_r$ cutting depth [mm] | 5 | (*) | < 1 | < 0,5 |

### *Milling*

| | Rough machining | | |
|---|---|---|---|
| Type of insert | P25-P35 not coated | P25-P35 coated | HSS |
| $V_c$ cutting speed [m/min] | 120 ÷ 140 | 160 ÷ 180 | (*) |
| $f_z$ feed [mm] | 0,15 ÷ 0,3 | 0,15 ÷ 0,3 | (*) |
| $a_r$ cutting depth [mm] | 2 ÷ 4 | 2 ÷ 4 | (*) |

| | Pre-finishing | | |
|---|---|---|---|
| Type of insert | P10-P20 not coated | P10-P20 coated | HSS |
| $V_c$ cutting speed [m/min] | 140 ÷ 160 | 180 ÷ 200 | (*) |
| $f_z$ feed [mm] | 0,2 ÷ 0,3 | 0,2 ÷ 0,3 | (*) |
| $a_r$ cutting depth [mm] | < 2 | < 2 | (*) |

| | Finishing | | |
|---|---|---|---|
| Type of insert | P10-P20 not coated | P10-P20 coated | Cermet P15 |
| $V_c$ cutting speed [m/min] | 200 ÷ 240 | 250 ÷ 270 | 300 ÷ 340 |
| $f_z$ feed [mm] | 0,05 ÷ 0,2 | 0,05 ÷ 0,2 | 0,05 ÷ 0,2 |
| $a_r$ cutting depth [mm] | 0,5 ÷ 1 | 0,5 ÷ 1 | 0,3 ÷ 0,5 |

*(*) not advisable*



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### *Drilling*

| Type of insert | tip with interchangeable inserts | HSS | brazed tip |
|---|---|---|---|
| $V_c$ cutting speed [m/min] | 130 ÷ 160 | (*) | 90 ÷ 120 |
| $f_z$ feed per turn [mm/turn] | 0,05 ÷ 0,15 | (*) | 0,15 ÷ 0,25 |

*(*) not advisable*

### *General formulae*

| Type of machining | **Drilling** | **Milling** |
|---|---|---|
| n: number of turns of mandrel | $V_c * 1000 / \pi * D_c$ | $V_c * 1000 / \pi * D_c$ |
| $V_f$: feed speed [m/min] | $V_f = f_z * n$ | $V_f = f_z * n * z_n$ |
| $f_z$ feed per turn [mm/turn] | - | $f_n = V_f / n$ |
| Note | $D_c$: Milling cutter or tip diameter [mm]<br>$V_c$: cutting speed [m/min]<br>$f_z$: feed [mm] | $f_n$: feed per turn [mm/turn]<br>$z_n$: No. of milling cutter inserts |

## Welding

In order to obtain the best results, we recommend the following procedure:

| **Welding technique** | TIG | MMA |
|---|---|---|
| **Pre-heating at** | 250 - 300 °C | |
| **Heat treatment** | Stress relieving (see heat treatment paragraph) | |

## Electrical Discharge Machining (EDM)

LUCCHINI 2738 can be machined by EDM to obtain complex shape. Afterwards we advise to carry out the stress relieving procedure.

## Process and materials selection for product recyclability

According to the potential of steel recycling, Lucchini RS is adopting a strategy for environmental excellence in designing and manufacturing its tool steel grades, putting eco-effectiveness into practice.

The main adopted steps are:

- to carry out an environmental assessment on processes and products, with the minimum use of virgin materials and non-renewable forms of energy;
- to move toward zero-waste manufacturing processes, considering that the ultimate destination of scrapped steel moulds becomes food for the next steel making process, that is the "waste equals food" philosophy;
- to carry out a life cycle assessment for each product and process, minimizing the environmental cost of product and service over its complete life cycles, from creation to disposal, that is the "Cradle to Cradle" philosophy



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## Quick comparison guide among the different steel grades

The following table shows a quick comparison among the main characteristics of pre-hardened steel grades traditionally used in plastic moulding.

| Tool Steels for plastic | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | LUCCHINI | | | | | | | KEYLOS | | | | | |
| | | 1730 | 7225 | 2311 | 2312 | 2738 | P20 | P20HH | UP | 30 | 35 | 40 | 35 EVO | 40 EVO |
| HB | Min | - | 220 | 280 | 280 | 290 | 290 | 320 | 280 | 290 | 320 | 360 | 320 | 360 |
| | Max | 200 | 270 | 330 | 330 | 340 | 330 | 360 | 330 | 330 | 360 | 400 | 360 | 400 |
| Maximum thickness [mm] | | 300 | 400 | 500 | 500 | 1.000 | 1.000 | 1.000 | 800 | 1.000 | 1.000 | 500 | 1.300 | 800 |
| Wear Resistance | | 1 | 1 | 2 | 2 | 2 | 2 | 3 | 2 | 2 | 3 | 4 | 3 | 4 |
| Through Hardening in the section | | 1 | 1 | 2 | 2 | 3 | 3 | 3 | 3 | 4 | 4 | 4 | 4 | 4 |
| Toughness | | 1 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 3 | 3 | 2 | 3 | 3 |
| Machinability | | 3 | 2 | 2 | 3 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| Polishing | | 1 | 1 | 2 | 0 | 2 | 2 | 2 | 2 | 3 | 3 | 3 | 3 | 3 |
| Photo-engraving | | 2 | 2 | 3 | 0 | 3 | 3 | 3 | 3 | 4 | 4 | 4 | 4 | 4 |
| Welding (reparing) | | 3 | 3 | 2 | 2 | 2 | 3 | 3 | 2 | 3 | 3 | 3 | 3 | 3 |

4 Excellent 3 Very Good 2 Good 1 Normal 0 Unsuitable



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