

**LUCCHINI** 2316

**STAINLESS STEEL FOR PROCESSING  
CHEMICALLY AGGRESSIVE AND  
ACID-RELEASING PLASTIC MOULDS**

**FORGING  
VALUES  
IN TOOL  
STEELS**

IMPROVEMENT PASSION  
COURAGE GROUP  
PEOPLE CUSTOMER SUCCESS

GROUP  
**LUCCHINI** RS

## General characteristics

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LUCCHINI 2316 is a martensitic stainless steel, resistant to corrosion, manufactured through a 'super clean' technology that guarantees high microcleanness levels.

Corrosion resistance allows the surface characteristics of the mould to be maintained over time and, as consequence, the die can be stocked with no need for special precautions to be taken and with the certainty of being able to use the mould whenever needed.

## Delivery conditions

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LUCCHINI 2316 is supplied in annealed or quenched and tempered condition in a dimensional range up to 300 mm in thickness.

In annealed condition the surface hardness is lower than 250 HB in quenched and tempered condition the surface hardness is 280 – 330 HB and the mid-thickness hardness value is guaranteed in section up to 350 mm, according to the following correlation:  $(HB_{\text{Surface, min required}} - HB_{\text{Core}}) \leq 20\text{HB}$ .

## Main features

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- excellent machinability;
- excellent suitability for photo-engraving;
- excellent suitability for polishing;
- excellent suitability for nitriding, in order to increase the wear resistance;
- excellent wear resistance;
- Good resistance to corrosion.

## Main application

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- moulds for corrosive plastic materials (PVC, recycled polymers, etc.);
- moulds for the automotive industry and optical parts (head lamp components);
- moulds for medical instruments;
- moulds for food industry products;
- moulds for the cosmetics industry;
- moulds for rubber pressing;
- dies and gauges for PVC extrusion;
- mechanical parts for extrusion presses (ex. extrusion heads).

## Chemical analysis

	Range	C [%]	Si [%]	Mn [%]	Cr [%]	Mo [%]	Ni [%]
<b>LUCCHINI 2316</b> Alloying [% in weight]	min	0,33	-	-	15,00	1,00	/
	max	0,43	1,00	1,00	17,50	1,30	1,00

Comparison with international classifications:

**W. Nr.** 1.2316

**DIN EN ISO 4957:** X38CrMo16

## Physical and mechanical properties

### Main physical properties

<b>LUCCHINI 2316</b>	20°C	250°C	500°C
<b>Young modulus E</b> [MPa]	210	198	177
<b>Coefficient of linear thermal expansion <math>\alpha</math></b> [10 <sup>-6</sup> /K]	-	11,4	12,2
<b>Thermal conductivity <math>\lambda</math></b> [W/mK]	17,5	20,7	23,2

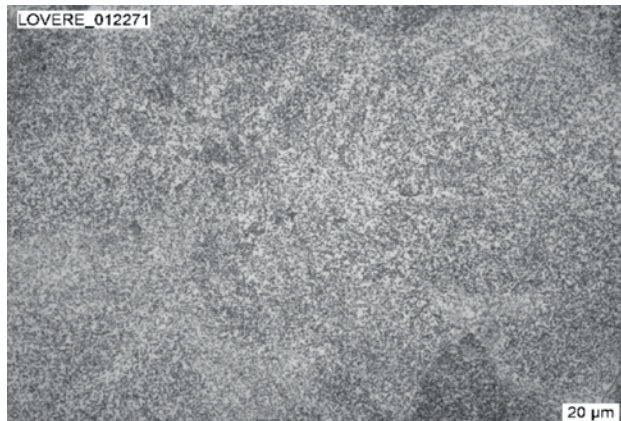
### Main mechanical properties

<b>LUCCHINI 2316</b>	20°C	200°C
<b>Ultimate tensile strength UTS</b> [MPa]	1100	980
<b>Yield strength YS</b> [MPa]	900	780
<b>Elongation (A)</b> [%]	15	16
<b>Reduction of area (Z)</b> [%]	45	47

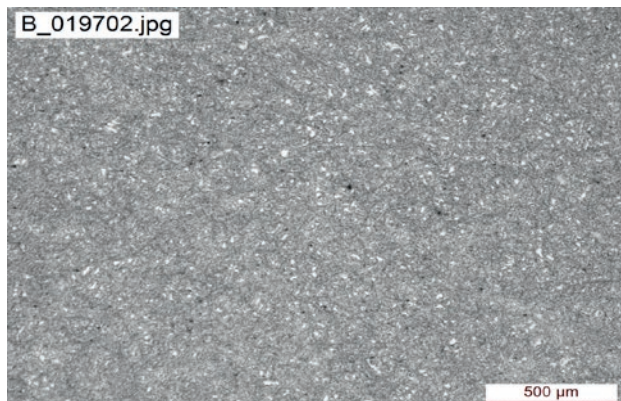
The above mentioned are average values of a sample hardened at 1030°C, quenched and tempered to achieve hardness value of 40 HRC.

## Microstructure

The main microstructure of LUCCHINI 2316 in annealed condition is globular perlite with carbides; in quenched and tempered condition is tempered martensite.

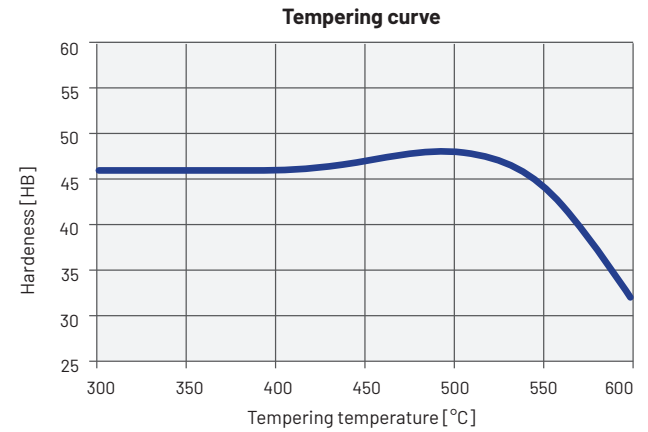


500x - Globular perlite with carbides



500x - Tempered martensite

## Surface hardness vs tempering temperature



**Remark:** the above data are representative of the typical behaviour of a 250 mm thick block made in LUCCHINI 2316 and are reported for information only.

## Heat treatment

LUCCHINI 2316 is supplied in annealed condition with a hardness value below 250 HB or in quenched and tempered conditions with no need for additional heat treatment operations.

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.

### Soft annealing

<b>Suggested temperature</b>	750°C
<b>Soaking time</b>	60 min every 25 mm thickness
<b>Cooling</b>	Slow cooling in furnace (20°C/h)

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

### Stress relieving

<b>Suggested temperature</b>	650°C
<b>Soaking time</b>	60 min every 25 mm thickness
<b>Cooling</b>	Slow cooling in furnace (20°C/h)

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

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

A pre-heating step at 700°C is recommended to reduce the stress during the heating up to austenitizing temperature.

<b>Suggested temperature</b>	1030°C
<b>Soaking time</b>	60 min every 25 mm thickness
<b>Cooling</b>	Polymer or water quench

### Tempering

<b>Suggested temperature</b>	Depending on the required mechanical properties
<b>Soaking time</b>	120 min every 25 mm thickness
<b>Cooling</b>	Still air

The tempering temperature should be selected from 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.



## Polishing and photo-engraving

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LUCCHINI 2316 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: **3 Very good**

Suitability for engraving: **3 Very good**

Rating scale:

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

## Guidance for machining

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

### Turning

Type of insert	Rough machining		Finish machining	
	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

Type of insert	Rough machining		
	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	(*)

Type of insert	Pre-finishing		
	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	(*)

Type of insert	Finishing		
	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

## 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] $V_c$ : cutting speed [m/min] $f_z$ : feed [mm]	$f_n$ : feed per turn [mm/turn] $z_n$ : No. of milling cutter inserts



## Welding

Welding on LUCCHINI 2316 is not recommended but, if it cannot be avoided, please consult Lucchini RS specialists.

The following information about welding procedure on LUCCHINI 2316 is only indicative.

Material condition	Annealed	Hardened and tempered
Welding technique	TIG	
Pre-heating at	250 – 300°C	
Recommended Heat treatment	Heating at 680 °C and cooling at room temperature Tempering at 10-20 °C below the temperature of the last tempering	

## Electrical Discharge Machining (EDM)

LUCCHINI 2316 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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**LUCCHINI RS**