LUCCHINI 2085

MARTENSITIC STAINLESS STEEL FOR SPECIAL PLASTIC MOULDS THAT NEED HIGH DEGREE OF RESISTANCE IN AGGRESSIVE ENVIRONMENTS AND GOOD MACHINABILITY

General characteristics

LUCCHINI 2085 is an advanced martensitic stainless steel, Chromium based, for plastic moulds that need resistance to wear and corrosion, combined with a good machinability in annealed conditions.

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.

Constant development in processing technologies require the use of LUCCHINI 2085, thanks to its high fatigue, wear and corrosion resistance, combined with its good machinability in annealed condition.

Delivery conditions

LUCCHINI 2085 is supplied in annealed or quenched and tempered condition in a dimensional range up to 350 mm in thickness.

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

Main features

- good hardness and wear resistance;
- good corrosion resistance;
- homogeneous mechanical properties throughout the mould
- excellent machinability in annealed conditions;
- good hardening stability and low distorsion;

Main application

- 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 [%]	S [%]
LUCCHINI 2085 Alloying [% in weight]	min	0,30	-	0,30	15,00	0,05
	max	0,40	1,00	0,60	16,50	0,10

Comparison with international classifications:
W. Nr. 1.2085
DIN EN ISO 4957: X35CrS16

Physical and mechanical properties

Main physical properties

LUCCHINI 2085	20°C	250°C	500°C
Young modulus E [MPa]	210	198	177
Coefficient of linear thermal expansion α [10-6/K]	-	11,5	12,1
Thermal conductivity λ [W/mK]	16,5	19,8	24,1

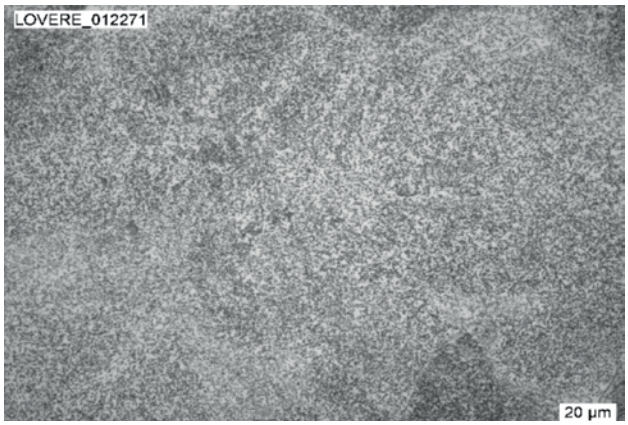
Main mechanical properties

LUCCHINI 2085	20°C	200°C
Ultimate tensile strength UTS [MPa]	1130	1020
Yield strength YS [MPa]	940	915
Elongation (A) [%]	15	16
Reduction of area (Z) [%]	45	47

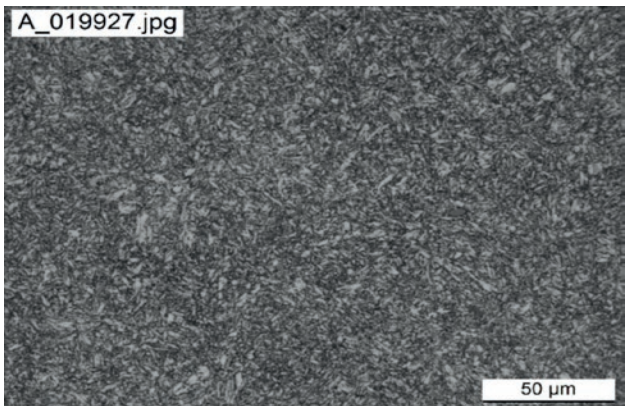
The above mentioned are average values of a sample hardened at 1030°C, quenched and tempered to achieve hardness value of 40 HRC.

Microstructure

The main microstructure of LUCCHINI 2085 in annealed condition is globular perlite with carbides; in quenched and tempered condition is tempered martensite.

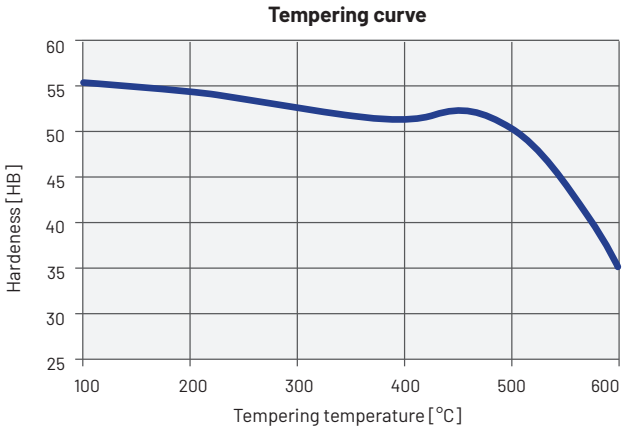


500x – Globular perlite with carbides

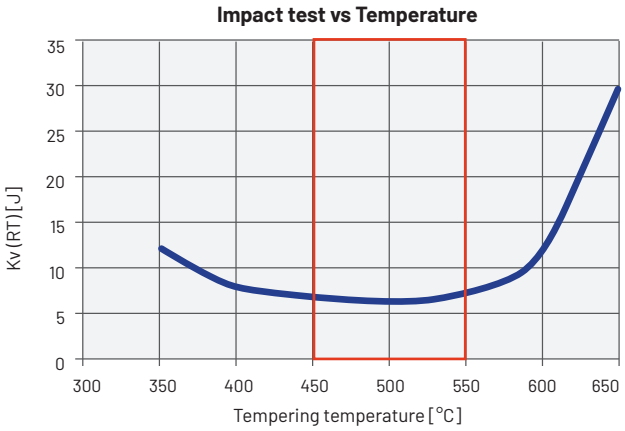


500x – Tempered martensite

Surface hardness vs tempering temperature



Toughness (Charpy V-notch test at 20°C) vs tempering temperature



Remark: the above data are representative of the typical behaviour of a 300 mm thick block made in LUCCHINI 2085 and are reported for information only.

Heat treatment

LUCCHINI 2085 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

Suggested temperature	750°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	150 - 430°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; the range 450 – 550°C is not recommended, because of their possible embrittling effects.

Hardening

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

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

Tempering

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

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

Tempering repeated two times are recommended, in order to reduce the amount of retained austenite.

The suggested temperature of tempering should be outside the not recommended tempering range of 450 – 550°C, because of their possible embrittling effects (see the graph Toughness vs tempering temperature reported above).

The two optimum tempering temperatures are:
- 350°C: highest strength, high toughness;
- 600°C: moderate strength, high toughness.

If the not recommended tempering range cannot be avoided, in order to reach very high values of Hardness (around 50 HRC) on large section moulds, please consult Lucchini RS specialists.

A slightly secondary hardening effect is observed in the vicinity of 500°C after tempering, which can be attributed to the precipitation of Cr23C6 carbides heterogeneously distributed in the martensite matrix and that can lead to the loss of corrosion resistance of the steel.

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

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

Polishing and photo-engraving

LUCCHINI 2085 is not suitable material when high polishing and photoengraving properties are needed.

Polishing for graining: 2 Good
Suitability for medium gloss polishing:1 Normal
Suitability for mirror polishing: 0 Unsuitable
Suitability for engraving: 0 Unsuitable

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

	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

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 2085 is not recommended but, if it cannot be avoided, please consult Lucchini RS specialists.

The following information about welding procedure on LUCCHINI 2085 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 2085 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

Via Giorgio Paglia, 45
24065 LOVERE (BG) - Italy
Phone +39 035 963724

www.lucchinirs.com

GROUP LUCCHINI RS