FORGING &
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GROUP
LUCCHINI RS

ESKY® LOS 2083

Martensitic stainless steel
for special plastic moulds that
need high degree of resistance
in aggressive environments
in ESR quality

LOOK BEYOND

General characteristics

EskyLos® 2083 is an advanced martensitic stainless steel, Chromium based, for plastic moulds that need resistance to wear and corrosion.

EskyLos® 2083 is the ideal option if the following characteristics are simultaneously required:
- good hardness and wear resistance after heat treatment;
- soft corrosion resistance;
- homogeneous mechanical properties throughout the mould, up to 500 mm in thickness.

EskyLos® 2083 is obtained through a special 'super clean' manufacturing process, followed by the ESR (Electro-Slag-Melting) technology.

This technology offers the following advantages:
- increase of material homogeneity;
- high micro-cleanness level;
- total isotropy of the material;
- very low segregation level.

Resistance to corrosion allows the surface characteristics of the mould to be maintained over time.

This means that 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.

The expensive and complicated operations of cleaning and setting up the die are not needed before usage.

EskyLos® 2083 is normally supplied in the annealed condition with surface hardness lower than 220 HB, in order to guarantee excellent machinability.

Upon request, EskyLos® 2083 can be supplied in the pre-hardened condition with hardness 300-340 HB.

EskyLos® 2083 offers the following advantages:
- good machinability in annealed conditions (HB < 250);
- good hardening stability and low distorsion;
- good wear resistance;
- good corrosion resistance;
- excellent polishability in hardened condition.

Constant development in processing technologies require the use of EskyLos® 2083, thanks to its high fatigue, wear and corrosion resistance, combined with its excellent dimensional stability and extremely low distortions.

Thanks to its quasi-isotropic properties of ESR quality, EskyLos® 2083 represents one of the most important tough options, for highly resistant plastic moulds that need very high pressure strength, excellent resistance to abrasion and corrosion.

The increasing in the use of synthetic and abrasive materials has led manufacturers to use EskyLos® 2083 also when suitability for polishing and graining, combined with abrasion, corrosion and compression resistance, are required.

This grade is suitable for the production of moulds up to 500 mm in thickness subject to corrosive and abrasive actions due to aggressive polymers (PVC, recycled polymers, etc.) or to unfavorable atmospheric conditions (high humidity / salinity).

EskyLos® 2083 is 100% ultrasonically inspected, according to the most demanding of NDT standards.

EskyLos® 2083 is also designed with the aim to guarantee the minimum use of virgin materials, moving toward the use of scrap categories difficult to be recycled, that can became food for the steel making production of EskyLos® 2083 grade.

Chemical analysis

	Range	C [%]	Si [%]	Cr [%]	Mn [%]
ESKYLOS 2083 Alloying [% in weight]	min	0,33	/	12,50	0,30
	max	0,43	1,00	13,50	0,60

Table for comparison of international classification

W. Nr.	**1.2083**
DIN EN ISO 4957	**X42Cr13**
AFNOR	**Z40C14**
AISI	**420**

Lucchini RS's tool steels have been researched and formulated in order to optimize the material performances.

The brand name identifies the Lucchini RS product and the number evokes the Werkstoff classification or other means of reflecting the characteristics of use.

Main applications

EskyLos® 2083 is suitable for the following applications:
- 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).

Physical and mechanical properties

Main physical properties

ESKYLOS 2083	20°C	250°C	500°C
Modulus of elasticity [GPa] (1GPa=1000 MPa)	210	198	177
Coefficient of thermal expansion from 20 °C at [10^{-6}/K]	-	11,5	12,1
Thermal conductivity [W/mK]	16,5	19,8	24,1

Main mechanical properties

ESKYLOS 2083	20°C	200°C	600°C
Ultimate Tensile strength (UTS) [MPa]	1.350	1.100	660
Yield stress (YS) [MPa]	1.200	980	485

These values are average values obtained on a sample which has been hardened at 980°C, quenched and tempered at 550 °C to achieve hardness of 42 HRc.

Heat treatments

EskyLos® 2083 is supplied in the annealed condition with hardness lower than 220 HB, or in the pre-hardened condition.

We suggest applying the following parameters if a different hardness is required or if heat treatment is needed.

This information is only indicative and must be adapted, depending on the different heat treatment requirements, facilities employed and on the thickness of the bar.

Soft annealing

Suggested temperature	750 °C
Soaking time	60 min every 25 mm thickness
Cooling	Slow in the furnace at max 20 °C/h to 600 °C, then at room temperature

Soft annealing is useful to improve machinability.
The obtained hardness is lower than 220 HB.

Stress Relieving

Suggested temperature range	150 - 430 °C
Soaking time	60 min every 25 mm thickness
Cooling	Slow in the furnace at max 20 °C/h to 200 °C,

The stress relieving temperature will be 50° C lower than the tempering temperature previously applied, but the range 450 – 550°C is not recommended, because of their possible embrittling effects.

Stress relieving is recommended where it is necessary to eliminate residual stresses induced by mechanical working or by a preceding heat treatment.

Hardening

Pre heating	700 °C
Heating	50 °C/h max
Soaking time	60 min every 25 mm thickness

Austenising suggested temperature	980°C - 1.040°C
Heating	50 °C/h max
Soaking time	60 min every 25 mm thickness
Cooling	water, air, gas

We suggest to carry out hardening on material supplied in the annealed condition and tempering immediately afterwards.

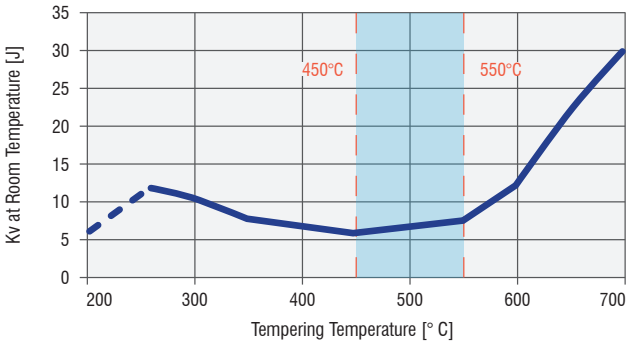
We suggest to avoid the highest temperature of austenitization, because higher is the temperature of austenitization and higher becomes the retained austenite content, not total transformed in martensite during cooling.

In any case, a sub-zero cooling treatment (cryogenic cooling technology) is recommended, in order to reach Mf temperature, that represents the final temperature transformation.

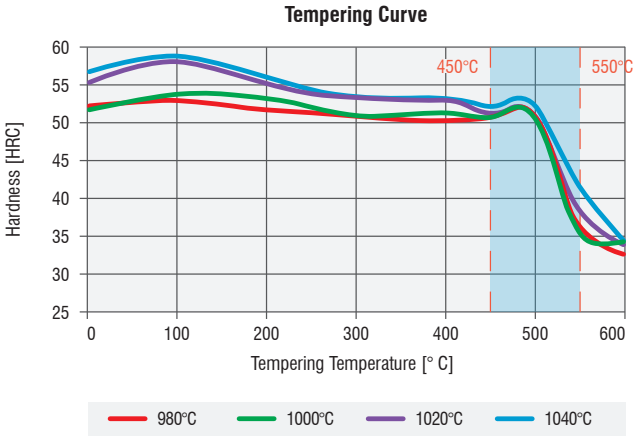
Tempering

Suggested temperature	The tempering temperature to be applied to the material depends on the required mechanical properties. See following graph.
Soaking time	60 min every 25 mm thickness
Cooling	Room temperature

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 (blu range), because of their possible embrittling effects.



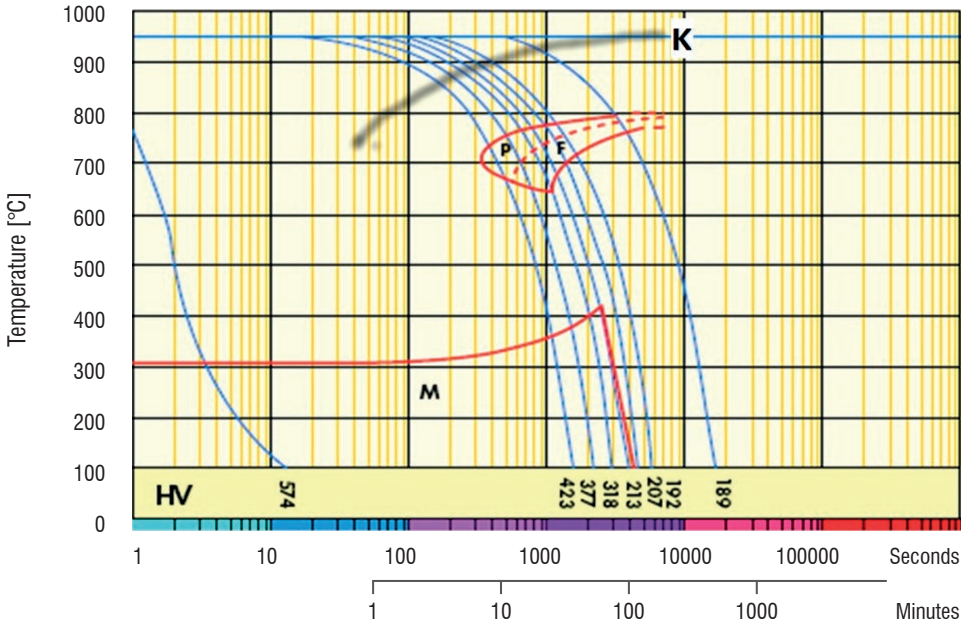
Tempering curve of EskyLos® 2083 samples austenitised at different temperatures between 980°C and 1.040 °C.

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.

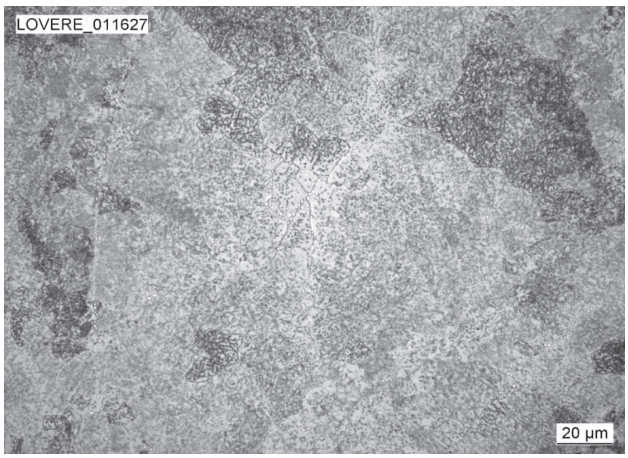
A slightly secondary hardening effect is observed in the vicinity of 500°C after tempering, which can be attributed to the precipitation of Cr23C6 carbides heterogeneously distributed in the martensite matrix and that can lead to the loss of corrosion resistance of the steel.

CCT Curve

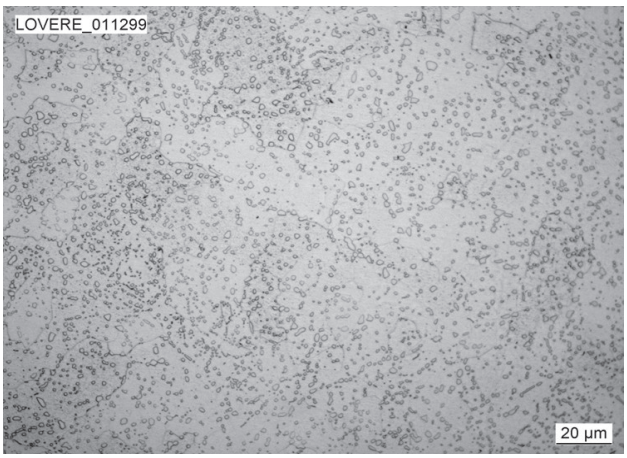


Microstructure of EskyLos® 2083

EskyLos® 2083 in annealed condition:
Globular Pearlite with dispersed Carbides



EskyLos® 2083 in hardening condition:
Tempered Martensite with dispersed Carbides



Quick comparison guide among the different grades for Plastics Industry

The following table shows a quick comparison among the most important characteristics of the pre-hardened grades normally applied in plastic moulding.

Lucchini RS Mould steel Family for plastics Industry

Special features and delivered conditions	Pre-hardened Not Corrosion Resistant Mould Steel Grades																		
	KEYLOS													ESKYLOS				BEYLOS	
	1730	1730 M	7225	ON	2312	2311	UP	2738 MSH	2738	PLUS	2738 MHH	2002	6959	2002	6959	2340	2365 M	2711	2714
HB in surface in Annealed condition	/	/	/	/	/	/	/	/	/	/	/	/	< 220	/	< 220	< 220	< 220	< 250	< 250
HB in surface Pre-hardened	≤ 200	≤ 210	220 - 270	280 - 330	280 - 330	280 - 330	280 - 330	280 - 330	290 - 340	300 - 350	320 - 360	360 - 400	370 - 410	360 - 400	370 - 410	400 - 450	400 - 450	370 - 410	370 - 410
Maximum thickness [mm]	300	300	500	500	600	600	800	800	1.000	800	1.200	1.200	500	500	500	500	500	500	700
Hardness and Wear Resistance	1	1	1	2	2	2	2	3	2	3	3	3	3	3	3	4	4	3	3
Degree of Through Hardening in the section	1	1	1	1	2	2	3	3	3	3	4	4	4	4	4	3	3	3	3
Toughness	1	1	2	2	1	3	3	3	2	3	3	3	4	3	4	3	2	4	4
Machinability after Annealing	/	/	/	/	/	/	/	/	/	/	/	/	3	/	3	3	3	3	3
Machinability after Hardening	3	3	2	1	4	2	2	2	2	2	2	2	1	2	1	1	1	1	1
Etch-Grainability	1	1	1	2	0	3	3	3	3	3	3	3	2	4	4	4	4	2	2
Polishability	2	2	2	2	0	3	3	3	3	3	3	3	2	4	4	4	4	3	3
Repair by Welding	1	1	1	0	0	1	1	2	1	2	2	2	1	2	1	1	1	1	1
Thermal Conductivity	3	3	2	2	2	2	2	3	2	3	3	3	2	3	2	1	1	2	2
Corrosion Resistance	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

4 Excellent 3 Very Good 2 Good 1 Normal 0 Unsuitable

Quick comparison guide among the different grades

The following table shows a quick comparison among the most important characteristics of the annealed and pre-hardened grades normally applied in corrosion resistant plastic moulding.

Lucchini RS Mould steel Family for plastics Industry								
Special features and delivered conditions	Annealed Corrosion Resistant						Precipitation Hardening	
	KEYLOS					ESKYLOS	ESKYLOS	
	2083	2084	2085	2316	2316S	2083	4542	2001
HB in surface in Annealed condition	< 220	< 220	< 220	< 220	< 220	< 220	< 355	310 - 350
HB in surface Pre-hardened or Hardened after machining	400 - 450	400 - 450	400 - 450	400 - 450	400 - 450	400 - 450	300 - 400	350 - 450
Maximum thickness [mm]	500	500	500	500	500	500	500	500
Hardness and Wear Resistance	4	4	4	4	4	4	2	3
Degree of Through Hardening in the section	3	2	2	2	2	3	4	3
Toughness	2	1	1	2	1	2	2	2
Machinability after Annealing	2	3	3	2	3	2	2	3
Machinability after Hardening	1	2	2	1	2	1	1	1
Etch-Grainability	2	1	1	2	1	4	4	4
Polishability	2	1	1	2	1	3	3	3
Repair by Welding	1	0	0	1	0	1	2	1
Thermal Conductivity	1	1	1	1	1	1	1	1
Corrosion Resistance	2	2	2	2	2	2	1	0

4 Excellent 3 Very Good 2 Good 1 Normal 0 Unsuitable

The information and the data presented here are typical or average values and are not a guarantee of maximum or minimum values.

Applications specifically suggested for materials described herein and in the quick comparison guide among the different grades are made solely for the purpose of illustration to enable the reader to make his own evaluation and are not intended as warranties, either express or implied, of fitness for these or other purposes.

The advantages of the ESR technology

The ESR (Electro-Slag-Melting) manufacturing technology offers the following advantages:

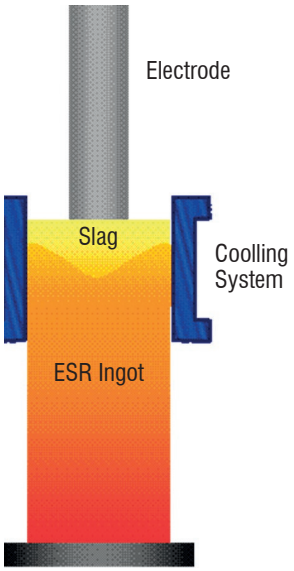
- increase of material toughness;
- high micro-cleanness level;
- total isotropy of the material;
- very low segregation level.

The ESR process is based on ingot remelting, through a traditional VD (vacuum degassing) process, using a particular copper ingot mould that contains basic slag.

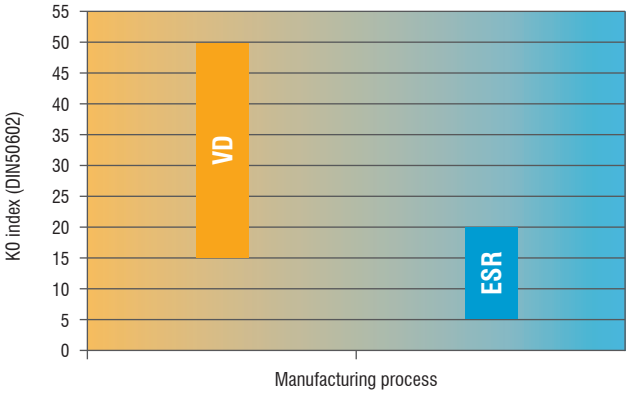
The ingot is remelted in a way that the liquid metal passes through the slag, which acts as a filter and retains the inclusions.

The process of solidification inside the ingot mould is faster than in a traditional process.

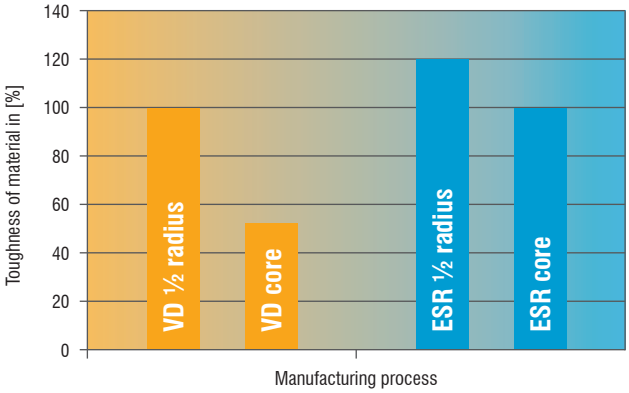
The result is homogeneous and isotropic steel.



K0 Purity level according to DIN 50602



Toughness vs. manufacturing process



Thanks to the ESR process, EskyLos® 2083 satisfies the most difficult requirements in terms of suitability to polishing. It is suitable for the manufacture of moulds subjected to mirror polishing and to high mechanical stress.

Guidance for machining

The following parameters are indicative only and must be adapted to the particular application and to the machinery employed. The data refer to material in the annealed condition. Hardness 220 HB max.

Turning

	Rough machining	Finish machining		
Type of insert	P20-P40 coated	HSS	P10-P20 coated	Cermet
V_c cutting speed [m/min]	170 ÷ 220	(*)	200 ÷ 250	240 ÷ 300
a_r cutting depth [mm]	1 ÷ 5	(*)	< 1	< 0,5

Milling

	Rough machining		
Type of insert	P25-P35 not coated	P25-P35 coated	HSS
V_c cutting speed [m/min]	140 ÷ 200	180 ÷ 260	(*)
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]	160 ÷ 240	240 ÷ 280	(*)
f_z feed [mm]	0,2 ÷ 0,3	0,2 ÷ 0,3	(*)
a_r cutting depth [mm]	1 ÷ 2	1 ÷ 2	(*)

	Finishing		
Type of insert	P10-P20 not coated	P10-P20 coated	Cermet P15
V_c cutting speed [m/min]	200 ÷ 260	240 ÷ 300	240 ÷ 330
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]	190 ÷ 220	(*)	60 ÷ 80
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

Approximate equivalent values between hardness and ultimate tensile strength

HB	530	520	512	495	480	471	458	445	430	415	405	390	375
HRc	54	53	52	51,1	50,2	49,1	48,2	47	45,9	44,5	43,6	41,8	40,5
MPa	1.900	1.850	1.800	1.750	1.700	1.650	1.600	1.550	1.500	1.450	1.400	1.350	1.300

HB	360	350	330	320	305	294	284	265	252	238	225	209	195
HRc	38,8	37,6	35,5	34,2	32,4	31	29	27	--	--	--	--	--
MPa	1.250	1.200	1.150	1.100	1.050	1.000	950	900	850	800	750	700	650

Welding

Welding on EskyLos® 2083 is not recommended.

If it cannot be avoided, please consult Lucchini RS specialists.

The following information about welding procedure on EskyLos® 2083 is only indicative.

Welding technique	TIG	TIG
Condition of material	Annealed	Hardened and tempered
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)

EskyLos® 2083 can be machined by EDM to obtain complex shape.

Afterwards it is advisable to stress relieving the material

Photo-engraving

Thanks to modern production processes and to the low s Slphur content, EskyLos® 2083 is suitable for photo-engraving to obtain various patterns.

Polishing

Thanks to the ESR (Electro-Slag-Remelting) manufacturing process, EskyLos® 2083 has excellent suitability to mirror polishing.

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 of its tool steel grades, putting eco-effectiveness into practice.

The main adopted steps are:

- conducting an environmental assessment on processes and products, with the minimum use of virgin materials and non-renewable forms of energy;
- moving toward zero-waste manufacturing processes, considering that the ultimate destinity of a scrapped steel mould becomes food for the next steel making process, that is the “waste equals food” philosophy;
- conducting a life cycle assessment for-each product and process, minimizing the environmental cost of product and service over its entire life cycles, from creation to disposal, that is the ”Cradle to Cradle” philosophy.

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