PLASTIC MOULD

KEYLOS®40 EVO

VALUE IN PERFORMANCE

THE CUSTOMISED SOLUTION FOR PLASTIC MOULDS

General characteristics

KEYLOS® 40 EVO is a special and innovative pre-hardened alloyed steel, suitable for the manufacture of big size injection moulds.

KEYLOS® 40 EVO represents the synthesis and the perfect balance of all the grades normally applied in this field and it is suited for a very wide range of applications in the plastics industry.

Thanks to an accurate design of the chemical alloying elements and thanks to a special heat treatment, KEYLOS® 40 EVO is characterized by a high degree of through hardening and it is suited when is required greater toughness balanced with very high hardness through to the core.

KEYLOS® 40 EVO represents the best option for highly resistant plastic moulds that need very high pressure strength, excellent resistance to abrasion and a shorter machining time.

Because of the low Carbon Equivalent content, the weldability level is excellent and KEYLOS® 40 EVO becomes safer in case of welding repair.

Delivery conditions

KEYLOS® 40 EVO is supplied in quenched and tempered condition in a wide dimensional range, from 200 mm up to 800 mm in thickness.

The surface hardness is 360 – 400 HB and the mid-thickness hardness value is guaranteed in section up to 800 mm, according to the following correlation: $(HB_{Surface,min\ required} - HB_{Core}) \leq 20HB$

Main features

- excellent toughness level;
- excellent suitability for photo-engraving;
- excellent suitability for polishing;
- excellent suitability for nitriding, in order to increase the wear resistance;
- excellent wear resistance;
- good weldability, improved with low C content.

Main application

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

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

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Chemical analysis

	Range	C [%]	Si [%]	Mn [%]	Cr [%]	Mo [%]	Ni [%]
KEYLOS®40 EVO Alloying [% in weight]	min	0,20	0,20	1,40	1,20	0,55	1,00
	max	0,30	0,50	1,70	1,60	0,75	1,30

Comparison with international classifications:
DIN 28MnCrNiMo6.5.4

Physical and mechanical properties

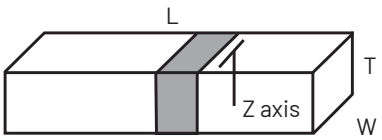
Main physical properties

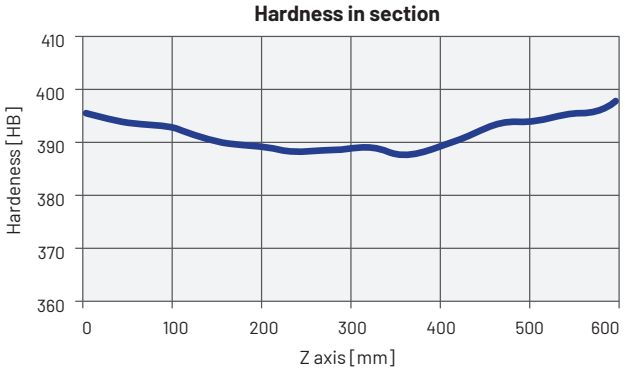
KEYLOS®40 EVO	20°C	250°C	500°C
Young modulus E [MPa]	210	194	176
Coefficient of linear thermal expansion α [10-6/K]	-	12,5	14,3
Thermal conductivity λ [W/mK]	34,5	34,0	33,8

Main mechanical properties

KEYLOS®40 EVO	20°C	200°C
Ultimate tensile strength UTS [MPa]	1200	1090
Yield strength YS [MPa]	1050	885
Elongation A [%]	14	17
Reduction in area Z [%]	45	50

Hardness profile





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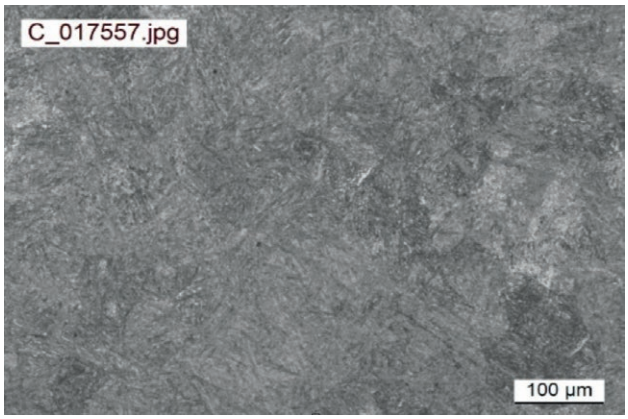
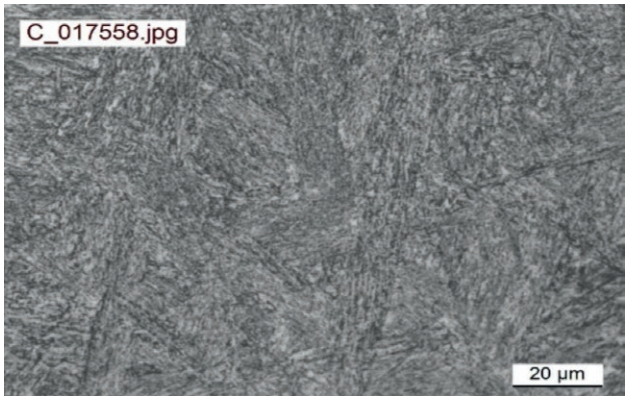
Microstructure

he main microstructure of KEYLOS® 40 EVO is tempered martensite.

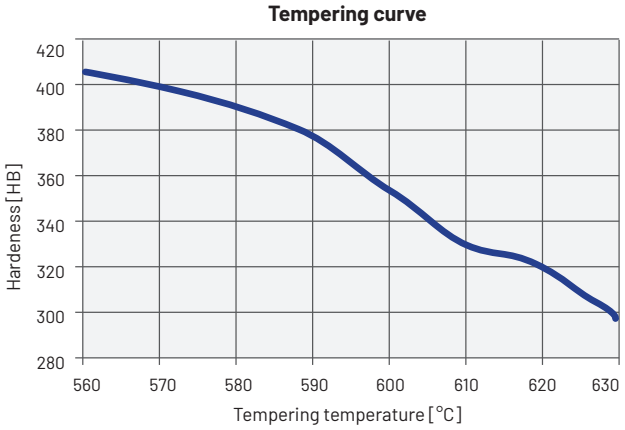


100x

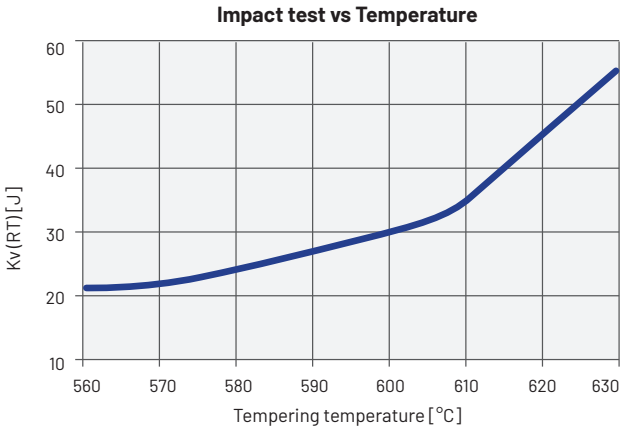


500x

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 600 mm thick block made in KEYLOS® 40 EVO and are reported for information only

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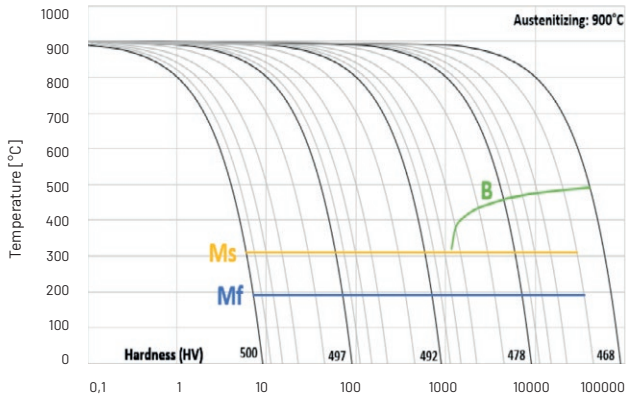
Heat treatment

KEYLOS® 40 EVO 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	550 °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	900 °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.

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

KEYLOS® 40 EVO is suitable for induction hardening. We recommend cooling at room temperature and tempering after induction hardening.

Nitriding

KEYLOS® 40 EVO is suitable for ionic and gas nitriding. This treatment is very useful for moulds subjected to extremely stressful applications.

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

Up-to-date nitriding procedures allow to minimize the dimensional variation of the piece.

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

- 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

KEYLOS® 40 EVO 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: 4 Excellent
Suitability for medium gloss polishing: 4 Excellent
Suitability for mirror polishing: 3 Very Good
Suitability for engraving: 4 Excellent

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] 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

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)

KEYLOS® 40 EVO 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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