

BEY[®] BEYLOS 2711

Special alloyed steel designed
for medium-surface plastic moulds
and for Hot Work Tools

General characteristics

BeyLos® 2711 is an alloy steel grade designed for the manufacture of dies, moulds, punches and other components subjected to high working temperatures and for high quality surface finishes.

BeyLos® 2711 is also suitable for plastic moulding applications, where high mechanical properties are required and it is recommended for processing transparent melts and for medium-surface plastic parts.

The best features of this steel are:

- high resistance to thermal shock and to heat cracking;
- good mechanical characteristics in hot condition;
- excellent mechanical characteristics in cold status;
- excellent toughness in hot condition and in cold status.

BeyLos® 2711 is obtained through a special 'super clean' manufacturing process, which allows a high level of micro-purity.

BeyLos® 2711 is normally supplied in the annealed condition with hardness values lower than 250 HB, thereby guaranteeing a good machinability.

For plastic moulding applications, BeyLos® 2711 is normally supplied in the pre-hardened condition, with a hardness value of 370-410 HB, in thicknesses up to 500 mm.

For the detected hardness values in standard sized products, the following correlation is usually valid and guaranteed:

$$(HB_{\text{Surface, min required}} - HB_{\text{Core}}) \leq 25HB$$

If subjected to suitable hardening, BeyLos® 2711 can reach a hardness of 46 HRC without affecting the toughness.

In order to improve further the mechanical characteristics of the surface, BeyLos® 2711 can be coated with PVD or PA/CVD methods.

Alternatively it can be hardened through flame hardening, induction tempering or subjected to nitriding.

The high micro-purity and structural homogeneity levels give this grade good suitability to polishing and photo-engraving.

Machinability is lower compared with KeyLos® 2311, because it is not Calcium treated. It may be necessary to adjust the cutting parameters, especially with deep hole drilling.

Chemical analysis

	Range	C [%]	Si [%]	Mn [%]	Ni [%]	Cr [%]	Mo [%]	V [%]
Alloying [% in weight]	min	0,50	0,15	0,60	1,50	0,85	0,30	0,07
	max	0,60	0,35	0,90	1,80	1,15	0,55	0,12

Table for comparison of international classification

W. Nr.	1.2711
AFNOR	55NCDV7
AISI	L6

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

BeyLos® 2711 is suitable for the following applications:

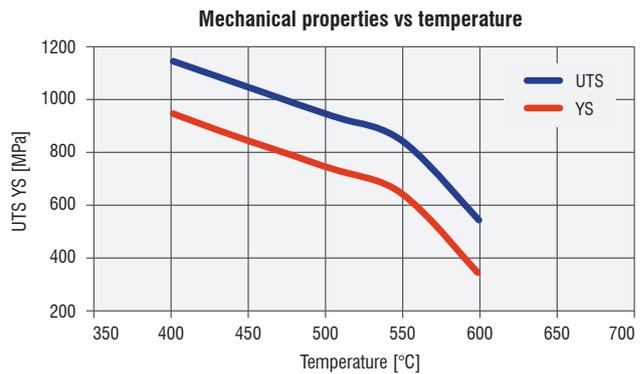
- large sized die blocks
- plastic moulds
- moulds subjected to low pressure
- chill moulds for gravity casting
- containers for die-casting presses
- bolsters / die holders
- sleeves for extrusion presses
- injection moulds.

Physical and mechanical properties

Main physical properties

BEYLOS 2711	20°C	400°C	600°C
Modulus of elasticity [GPa] (1GPa=1000 MPa)	210	198	178
Coefficient of thermal expansion [10 ⁻⁶ /K]	-	13,3	14,2
Thermal conductivity [W/mK]	25,5	25,0	24,6

These are average values obtained on a sample which has been hardened at 850 °C, quenched and tempered at 530 °C to achieve a hardness of 44 HRc.



Main mechanical properties

BEYLOS 2711	20°C	400°C	500°C	550°C	600°C
Ultimate tensile strength (UTS) [MPa]	1420	1300	1150	950	550
Yield stress (YS) [MPa]	1240	1090	950	750	350

Heat treatments

BeyLos[®] 2711 is supplied in the annealed condition or in the pre-hardened condition, depending on the application.

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

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

Soft annealing

Suggested temperature	700 °C
Soaking time	60 min every 25 mm thickness
Cooling	Slow in the furnace at max 25 °C/h to 600 °C , then at room temperature

Soft annealing is recommended if optimum machinability of the material is important. After soft annealing a hardness of around 250 HB is achieved.

Stress Relieving

Suggested temperature	550°C
Soaking time	60 min every 25 mm thickness
Cooling	Slow in the furnace at max 25 °C/h to 200°C , then at room temperature

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.

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

Hardening

Hardening should be carried out after the material has been pre-heated according to the following table.

First pre-heating temperature	550 °C
Soaking time	60 min every 25 mm thickness

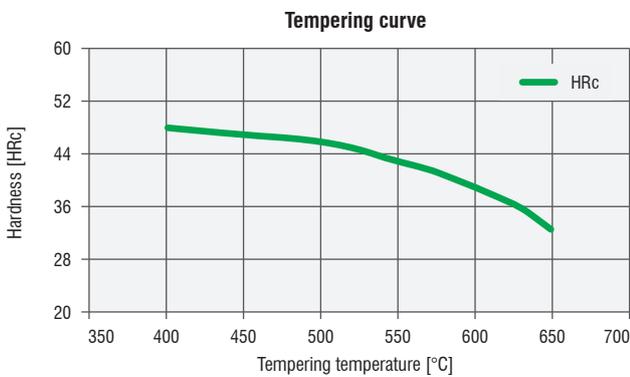
Austenitising temperature	850°C
Soaking time	60 min every 25 mm thickness
Cooling	Air, vacuum cooling, salt bath, polymer or water quench
Hardness after quenching	57 ÷ 58 HRc

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

Tempering

The temperature of the temper must be set on the basis of the required mechanical properties. A second temper at a temperature of 30-50° C below the maximum temperature previously applied will function as a stress relieving cycle.

Suggested temperature	Set on the basis of the required mechanical properties, see tempering curve
Soaking time	60 min every 25 mm thickness
Cooling	Room temperature



Tempering curve of a sample which has been austenitised at 850 °C and quenched.

In any case, other properties can be analyzed and studied deeper by Lucchini RS on specific Customer request: please consult Lucchini RS specialists of MET Department.

Variation in dimensions during heat treatment

During the heat treatment of BeyLos[®] 2711 the phase transformation points are exceeded.

Inevitably this causes a variation in the volume of the material.

For this reason we recommend leaving enough machining allowance to compensate for the change of dimension due to heat treatment. All the corners should be rounded off.

Nitriding

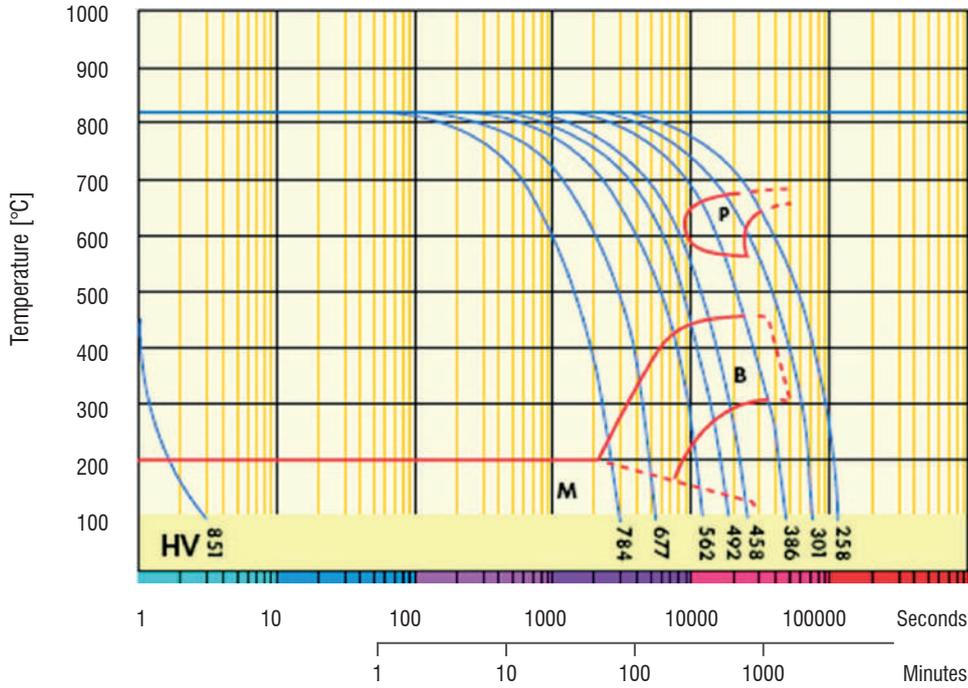
The purpose of nitriding is to increase the resistance of the material to wear and abrasion.

This treatment is very useful for components where high performance is necessary, as it extends the life of the material. We suggest nitriding the component in the hardened and tempered condition.

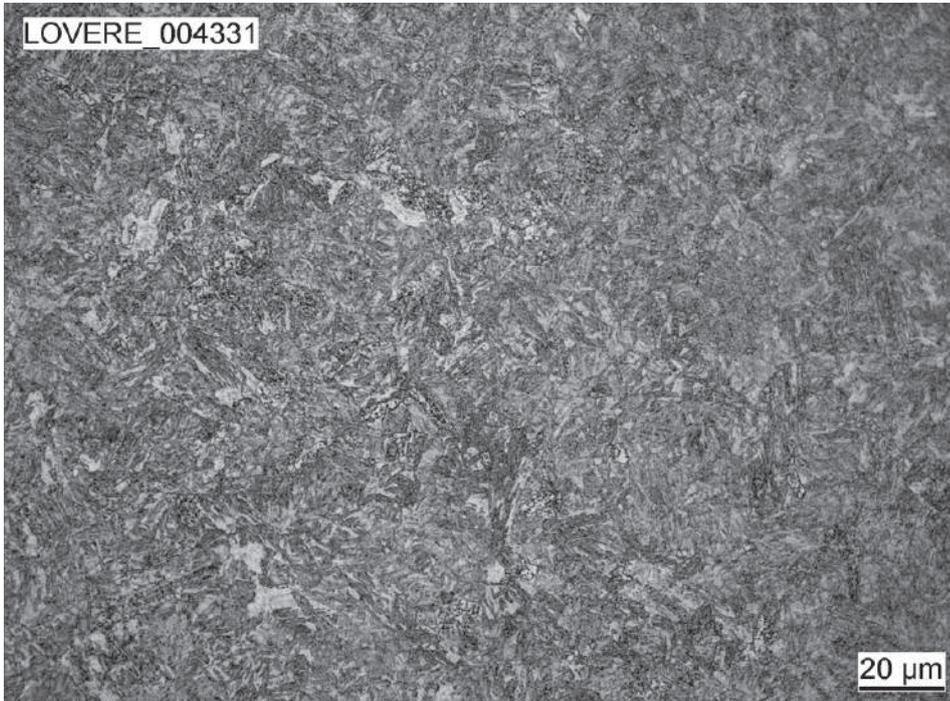
The tempering temperature must be at least 50 °C higher than the nitriding temperature.

Modern nitriding processes allow the original dimensions of the component to be maintained. We recommend heat treating the component in the finish machined condition.

CCT Curve



Microstructure of BEYLOS® 2711



The microstructure of BeyLos® 2711, after hardening, detected about 20 mm under surface is tempered martensite.

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 250 HB max.

Turning

Type of insert	Rough machining		Finish machining	
	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

Type of insert	Rough machining		
	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	(*)

Type of insert	Pre-finishing		
	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	(*)

Type of insert	Finishing		
	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 of BeyLos® 2711 can give good results if the recommended procedure is followed.

Being steel with high Carbon Equivalent content, BeyLos® 2711 is very sensitive to cracking.

We recommend carrying out pre-heating and heat treatment after welding.

Condition of material	Annealed with hardness 250 HB max	
Welding technique	TIG	MMA
Pre-heating at	250 ÷ 300 °C	
Recommended heat treatment	Heating of the material at 700 °C, cooling in the furnace to 600 °C at a rate of 20 °C/h, cooling at room temperature	
Condition of material	Hardened and tempered	
Welding technique	TIG	MMA
Pre-heating at	250 ÷ 300 °C	
Recommended heat treatment	550 °C or 50 °C lower than the tempering temperature previously applied	

Electrical Discharge Machining (EDM)

BeyLos® 2711 can be machined by EDM to obtain complex shape.

Afterwards it is advisable to stress relieving the material.

Chrome Plating

BeyLos® 2711 can be Chrome plated in order to enhance the mechanical characteristics on the surface.

Within 4 hours of Chrome plating, in order to prevent Hydrogen embitterment it is advisable to carry out heat treatment at 200°C for about 4 hours.

Photo-engraving

Thanks to modern production processes and to the low Sulphur content, BeyLos® 2711 is suitable for photo-engraving to obtain various patterns.

Polishing

BeyLos® 2711 is particularly suitable for 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 destiny 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.