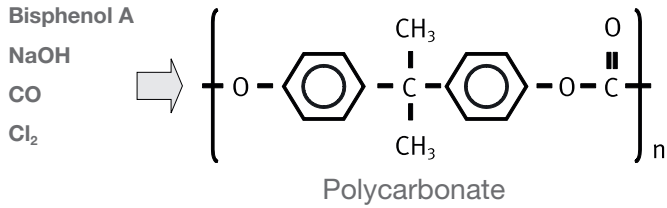


Makrolon® for Optical Data Storage



Roadmap of Makrolon® OD2015

Polycarbonate chemistry

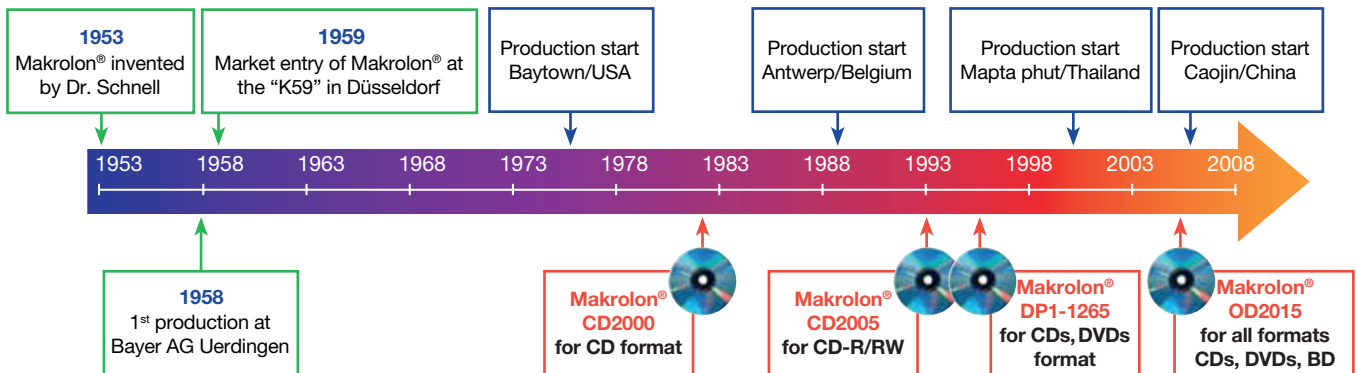


- High strength, stiffness and impact resistance
- High dimensional heat stability
- Non-toxic, no inherent taste
- Excellent electrical and dielectric properties
- Outstanding light transmittance in transparent grades
- Low temperature toughness

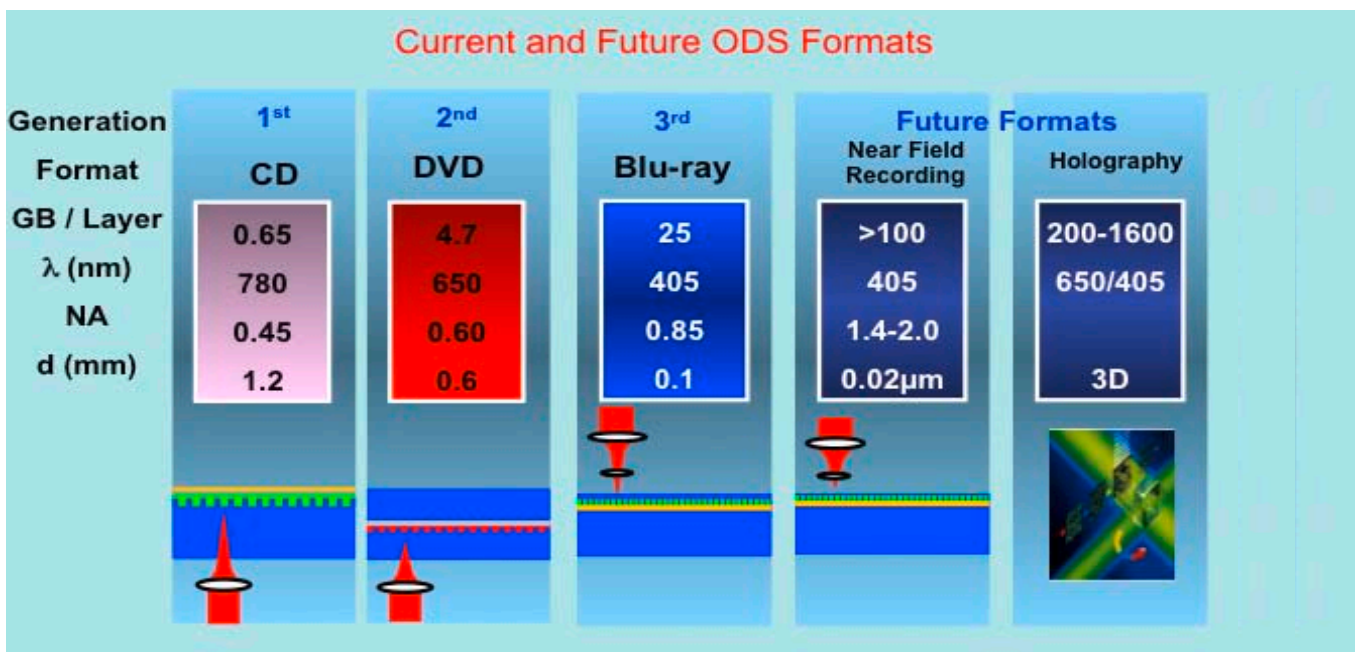


ODS (optical data storage) material roadmap

Makrolon® History – ODS (optical data storage) material



ODS (optical data storage) Format roadmap



Requirements on polymers for optical data storage disc

1. Transmission

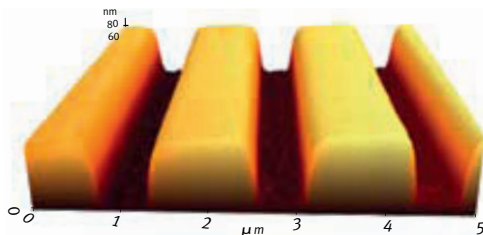
Makrolon® fulfils these requirements in an ideal manner. Makrolon® OD2015 has a transmission of >89% at 780 nm, 650 nm, 405 nm, for instance (1mm wall thickness).

2. Dimensional stability

Since the optical lens system is only able to correct very slight defocusing, the dimensional stability of optical data storage disc is of particular importance. Dimensional changes can result inter alia through a high moisture absorption or through the rearrangement of the molecules (crystallization). Neither of these can happen with Makrolon® OD2015, since it is permanently amorphous and only absorb a very small amount of moisture. The high softening point of Makrolon® grade means that discs will not be impaired through warpage at high temperatures – not even in cars, where temperatures of up to 100 °C are frequently encountered in the vicinity of the windows.

3. Reproduction accuracy and birefringence

In order to achieve optimum reproduction of the digitally-stored information, it is essential for the pit structure on the stamper to be precisely reproduced on the substrate disc. (see the picture AFM/CDR)



In addition, the birefringence of disc substrate should not exceed ± 50 nm optical path difference (single pass), since a number of effects are conditioned by the birefringence:

- widening of the focus point of the laser beam
- part of the circular polarized light from the substrate can fall back into the laser. This “optical feedback” gives rise to intensity fluctuations, turning the laser into a pulsating light source.

4. Mechanical properties and processability

Particular requirements are placed on the toughness of the substrate disc when in service. In addition, no microcrazes are allowed to occur during disc production. It is thus particularly important to obtain a high toughness level while maintaining the best possible flowability.

Makrolon® OD2015, which is currently supplied as materials for optical storage media has an MVR of 16.5 cm³/10 min (250 °C–2.16kg).

5. Purity requirements

Plastics for optical data storage discs have to meet very high purity requirements. While disc player systems can tolerate a certain amount of impurities without the sound quality suffering, contaminants are still undesirable. For this reason, commercial-scale production of Makrolon® OD2015 uses special equipment and precautions in order to prevent fish eyes in the polymer and to protect the pellets from external contamination.

Each batch that is supplied is checked for purity beforehand by means of a scanner.

Item \ Format	CD	DVD	Blu-ray Disc
Transmission	+	+	–
Dimensional Stability	+	++	+++
Reproduction Accuracy	+	++	+++
Birefringence	+	++	–
Mechanical properties	+	+	+
Processability	+	++	+++
Purity requirements	+	+	+

+ required – not required

General processing advice

1. Drying

Makrolon® OD2015 require a drying temperature of 120°C. A drying time of 3 to 4 h is necessary in a dry-air dryer. It is important that all the pellets experience a uniform, high level of drying. Insufficient and non-uniform drying will result in moisture streaks, stringing, wet nozzles and clouding in the disc. A residual moisture content of < 0.01% by weight should be aimed for in the dry pellets.

See also ATI 944 d, e “The drying of Makrolon® (PC) for ODS production”.

2. Storage

In our experience, Makrolon®, if stored as directed, can be kept for lengthy periods in its original packaging with practically no loss of quality. The packaging provides sufficient protection against dust and other contamination from outside.

To ensure appropriate storage, the following points should be observed: Constant, normal room temperature with minimal fluctuations (e.g. 18°C ± 5°C) and low to normal humidity is essential. Air conditioning is not necessary, but adequate ventilation should be provided.

Ideally, the storage temperature should be above 10°C. If the storage temperature has dropped significantly below room

temperature, the bags should be placed in intermediate storage and kept there until the entire quantity to be processed has reached the temperature of the production shop. Otherwise there is a risk of condensation forming on the cold granules.

The material should be stored in its original packaging – i.e. on shrinkwrapped pallets – for as long as possible. If the pallets have already opened, the granules should be kept in sealed sacks.

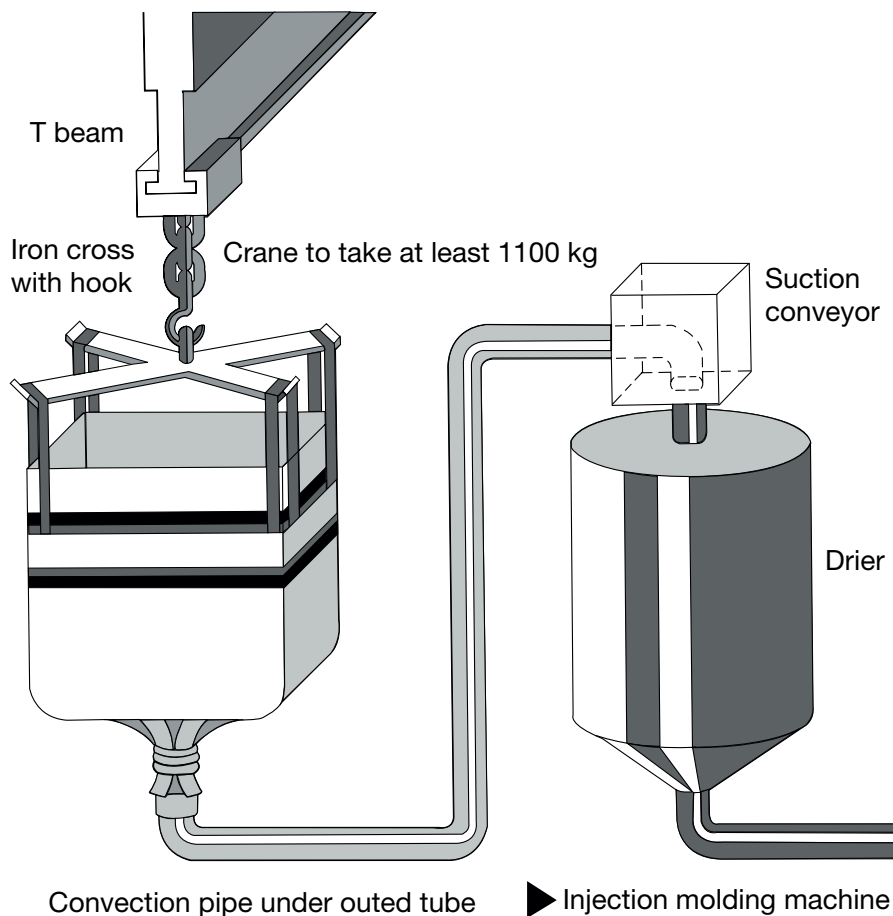
The layout of the store must comply with the relevant fire safety and industrial hygiene regulations.

It is also important to remember that the granules must always be dried before processing.

Prolonged exposure of Makrolon® bags to light containing UV rays should be avoided, since this may lead to color changes in the outer layers of the granules.

3. Big bag handling

To ensure particular purity in the finished discs, special forms of packaging are thus required, together with special methods for conveying the pellets into the injection molding machine. A special designed, hermetically sealed 800 kg container (FIBS) protect the raw materials from dust both during transport and while they are being fed to the machines.



Processing parameters for all formats

Sumitomo example for all formats

SD40E – Example of CD Condition at Cycle Time 3.8 sec

SCALE : CLAMP FORCE ton PRESSURE kgf/cm²

			CYLINDER TEMP											
MACHINE SERIAL No.			Z15A	Z15	Z4	Z3	Z2	Z1	WATER					
DISC FOR	CD		SET	275.0	285.0	350.0	350.0	330.0	300.0	70.0	°C			
	120.0 mm		ACT	275.0	285.0	350.0	350.0	330.0	300.0	70.0	°C			
STAMPER	ID	mm	FILLING											
	OD	mm	5TH 4TH 3RD 2ND 1ST					STAGES			5V-4P			
	THICK	mm	POS	4.00	4.50	7.00	22.00	26.00	FILL.PRES		2230	kgf/cm ²		
	SUCTION	kPa	VEL	50.0	60.0	100.0	120.0	65.0	FILL.TIME		2.00	sec		
	No.							HOLD VEL		150.0	mm/sec			
MOLD	TYPE	Axxicon	7TH 6TH				HOLD PRESSURE							
	No.		TIME			sec	4TH 3RD 2ND 1ST							
	CAVITY	mm	POS			mm	TIME	0.00	0.00	0.15	0.05	sec		
RESIN	NAME	Makrolon	VEL				mm/s	PRESS		0	0	200	300	kgf/cm ²
	GRADE	OD2015	PLASTICIZING											
SCREW	TYPE		MODE	Pull Back			Slow Down			Plast End		Pull Back		
	DIAMETER	mm	SHARP	POS	0.00	mm	POS	24.00	30.00	mm	0.00		mm	
NOZZLE	R		R.P	VEL	5.0	mm/s	B.P	30	30	0	kgf/cm ²	5.0		mm/s
	HOLE	mm	POSITION					REV	300	280	80	rpm		
S/SIDE AIR BLOW	PRESS	MPa	INJECTION DETAIL											
	FLOW	rev/OP	INJECTION RESPONSE				UNIT RETRACT		FILL DELAY		PLAST DELAY			
M/SIDE AIR BLOW	PRESS	MPa	STANDARD		HELD ADVANCED		0.00		0.00		sec			
	FLOW	rev/OP	HOLD-PRESS RESPONSE		DELAY OPE		COOLING		START UP					
NOZZLE AIR BLOW	PRESS	MPa	STANDARD		0.00		0.00		2.10		+ 0.20		sec	
	FLOW	rev/OP	FILL COUNT START POS		V-P SWITCH		V-P PRESS		INTERVAL		5		shots	
PLATEN	WATER	ON	0.00	mm	POSITION	0	kgf/cm ²	0.00		sec	ON			
			CLAMP FORCE											
CLAMP FORCE	1ST		MODE		2ND		3RD		4TH		5TH			
	5.0	ton	PRESS 1		30.0		15.0						ton	
	Chg.TIME	0.01	sec	DELAY TIME		CLAMP TIME		1.00		50.00		sec		
	CLAMP CONF	80	%	0.12		CHANGE TIME		0.02		0.02				sec
INT.PL.DISTANCE		mm												
MOLD TEMP					MOTOR STATUS									
TEMP	S/MIR-ROR	M/MIRROR	SPRUE	M/BUSH	°C	IJ	RT	MD	E(CP)	IU	U			
	55.0	53.0	25.0	25.0		XOL(%)								
FLOW				l/min	TEMP									

SD40E – Example of CD-R Condition at Cycle Time 5.0 sec

SCALE : CLAMP FORCE ton PRESSURE kgf/cm²

			CYLINDER TEMP											
MACHINE SERIAL No.			Z15A	Z15	Z4	Z3	Z2	Z1	WATER					
DISC FOR CD-R 120.0 mm			SET	310.0	330.0	350.0	350.0	330.0	300.0	70.0	°C			
			ACT	310.0	330.0	350.0	350.0	330.0	300.0	70.0	°C			
STAMPER ID mm OD mm THICK mm SUCTION kPa No.			FILLING											
			5TH 4TH 3RD 2ND 1ST						STAGES		5V-4P			
			POS 4.00 4.50 7.00 22.00 26.00 mm						FILL.PRES		2230 kgf/cm ²			
			VEL 50.0 60.0 100.0 120.0 80.0 mm/s						FILL.TIME		2.00 sec			
									HOLD VEL		150.0 mm/sec			
MOLD TYPE Axxicon No. CAVITY mm			7TH 6TH				HOLD PRESSURE							
			TIME				TIME							
			POS				PRESS							
RESIN NAME Makrolon GRADE OD2015			VEL				4TH 3RD 2ND 1ST							
			TIME				PRESS							
SCREW TYPE DIAMETER mm			MODE		Pull Back		Slow Down		Plast End		Pull Back			
			SHARP		POS 0.00 mm		POS 24.00 30.00 mm				POS 0.00 mm			
NOZZLE R HOLE mm			R.P		VEL 5.0 mm/s		B.P		30 30 0 kgf/cm ²		5.0 mm/s			
			POSITION				REV		300 280 80 rpm					
S/SIDE AIR BLOW PRESS MPa FLOW rev/OP			INJECTION DETAIL											
			INJECTION RESPONSE				UNIT RETRACT				FILL DELAY		PLAST DELAY	
M/SIDE AIR BLOW PRESS MPa FLOW rev/OP			STANDARD				HELD ADVANCED				0.00		0.00 sec	
			HOLD-PRESS RESPONSE				DELAY OPE				COOLING		START UP	
NOZZLE AIR BLOW PRESS MPa FLOW rev/OP			STANDARD				0.00 0.00 sec				3.30		+ 0.20 sec	
			FILL COUNT START POS				V-P SWITCH V-P PRESS				INTERVAL		5 shots	
PLATEN WATER ON			0.00 mm		POSITION 0		kgf/cm ²		0.00 sec		ON			
			CLAMP FORCE											
1ST			MODE		2ND		3RD		4TH		5TH			
CLAMP FORCE 5.0 ton			PRESS 1		CLAMP FORCE 40.0		20.0		15.0					
Chg.TIME 0.01 sec			DELAY TIME		CLAMP TIME 1.00		0.50		50.00		sec			
CLAMP CONF 80 %			0.12 sec		CHANGE TIME 0.02		0.02				sec			
INT.PL.DISTANCE mm														
MOLD TEMP					MOTOR STATUS									
S/MIR-ROR M/MIRROR SPRUE M/BUSH					IJ		RT		MD		E(CP) IU U			
TEMP 107.0 105.0 50.0 50.0 °C					XOL(%)									
FLOW l/min					TEMP									

SD40E – Example of DVD Condition at Cycle Time 3.6 sec

SCALE : CLAMP FORCE ton PRESSURE kgf/cm²

			CYLINDER TEMP											
MACHINE SERIAL No.			Z15A	Z15	Z4	Z3	Z2	Z1	WATER					
DISC FOR DVD 120.0 mm			SET	300.0	320.0	350.0	350.0	330.0	300.0	70.0	°C			
			ACT	300.0	320.0	350.0	350.0	330.0	300.0	70.0	70.0	°C		
STAMPER ID mm OD mm THICK mm SUCTION kPa No.			FILLING											
			5TH 4TH 3RD 2ND 1ST					STAGES			5V-4P			
			POS	2.00	3.00	4.00	5.00	12.00	FILL.PRES		2230	kgf/cm ²		
			VEL	50.0	60.0	100.0	120.0	65.0	FILL.TIME		2.00	sec		
										HOLD VEL		150.0	mm/sec	
MOLD TYPE Axxicon No. CAVITY mm			7TH 6TH				HOLD PRESSURE							
			TIME			4TH 3RD 2ND 1ST		TIME		0.00	0.00	0.15	0.05	sec
			POS			PRESS		0	0	200	300	kgf/cm ²		
RESIN NAME Makrolon GRADE OD2015			PLASTICIZING											
			MODE	Pull Back		Slow Down		Plast End		Pull Back				
SCREW TYPE DIAMETER mm			SHARP	POS	0.00	mm	POS	13.00	15.80	mm	0.00	mm		
NOZZLE R HOLE mm			R.P	VEL	5.0	mm/s	B.P	30	30	0	kgf/cm ²	5.0	mm/s	
			POSITION	REV	300	280	80	rpm						
S/SIDE AIR BLOW PRESS MPa FLOW rev/OP			INJECTION DETAIL											
			INJECTION RESPONSE				UNIT RETRACT		FILL DELAY		PLAST DELAY			
M/SIDE AIR BLOW PRESS MPa FLOW rev/OP			STANDARD		HELD ADVANCED		0.00		0.00		sec			
			HOLD-PRESS RESPONSE		DELAY		OPE		COOLING		START UP			
NOZZLE AIR BLOW PRESS MPa FLOW rev/OP			STANDARD		0.00		0.00		1.90		+	0.20		sec
			FILL COUNT START POS		V-P SWITCH		V-P PRESS		INTERVAL		5		shots	
PLATEN WATER ON			0.00	mm	POSITION	0	kgf/cm ²	0.00		sec	ON			
1ST CLAMP FORCE 5.0 ton Chg.TIME 0.01 sec CLAMP CONF 80 % INT.PL.DISTANCE mm			CLAMP FORCE											
			MODE				2ND 3RD 4TH 5TH							
			PRESS 1				CLAMP FORCE		30.0	15.0	15.0		ton	
			DELAY TIME				CLAMP TIME		1.00	50.00	50.00		sec	
			0.12 sec				CHANGE TIME		0.02	0.02	0.02		sec	
MOLD TEMP					MOTOR STATUS									
S/MIR-ROR		M/MIRROR	SPRUE	M/BUSH	IJ	RT	MD	E(CP)	IU	U				
TEMP	95.0	95.0	40.0	40.0	XOL(%)									
FLOW					TEMP									

SD40E – Example of DVD +/- R Condition at Cycle Time 4.3 sec

SCALE : CLAMP FORCE ton PRESSURE kgf/cm²

MACHINE SERIAL No.		CYLINDER TEMP												
DISC FOR		DVD +/- R	Z15A	Z15	Z4	Z3	Z2	Z1	WATER					
SET			300.0	330.0	360.0	360.0	330.0	300.0	70.0		°C			
ACT		120.0 mm	300.0	330.0	360.0	360.0	330.0	300.0	70.0		°C			
STAMPER	ID	mm	FILLING											
	OD	mm	5TH 4TH 3RD 2ND 1ST					STAGES					5V-4P	
	THICK	mm	POS	2.00	3.00	4.00	5.00	11.00	mm	FILL.PRES	2230	kgf/cm ²		
	SUCTION	kPa	VEL	50.0	60.0	100.0	120.0	80.0	mm/s	FILL.TIME	2.00	sec		
	No.									HOLD VEL	150.0	mm/sec		
MOLD	TYPE	Axxicon	HOLD PRESSURE											
	No.		7TH 6TH		4TH 3RD 2ND 1ST									
	CAVITY	mm	TIME			sec	TIME	0.00	0.00	0.15	0.05	sec		
RESIN	NAME	Makrolon	POS			mm	PRESS	0	0	200	300	kgf/cm ²		
	GRADE	OD2015	VEL			mm/s	PLASTICIZING							
SCREW	TYPE		MODE	Pull Back			Slow Down			Plast End		Pull Back		
	DIAMETER	mm	SHARP	POS	0.00	mm	POS	13.00	15.80	mm	0.00	mm		
NOZZLE	R		R.P	VEL	5.0	mm/s	B.P	30	30	0	kgf/cm ²	5.0		
	HOLE	mm	POSITION				REV	350	300	80	rpm			
S/SIDE AIR BLOW	PRESS	MPa	INJECTION DETAIL											
	FLOW	rev/OP	INJECTION RESPONSE				UNIT RETRACT				FILL DELAY		PLAST DELAY	
M/SIDE AIR BLOW	PRESS	MPa	STANDARD				HELD ADVANCED				0.00		0.00	
	FLOW	rev/OP	HOLD-PRESS RESPONSE				DELAY OPE				COOLING		START UP	
NOZZLE AIR BLOW	PRESS	MPa	STANDARD				0.00		0.00		2.60		+ 0.20	
	FLOW	rev/OP	FILL COUNT START POS		V-P SWITCH		V-P PRESS		INTERVAL		5		shots	
PLATEN	WATER	ON	0.00		mm		POSITION		0		kgf/cm ²		0.00	
		1ST	CLAMP FORCE											
CLAMP FORCE		5.0	MODE	2ND 3RD 4TH 5TH										
Chg.TIME		0.01	sec	PRESS 1		CLAMP FORCE		40.0	20.0	15.0			ton	
CLAMP CONF		80	%	DELAY TIME		CLAMP TIME		1.00	0.50	50.00	sec			
INT.PL.DISTANCE			mm	0.12		CHANGE TIME		0.02	0.02	0.02	sec			
MOLD TEMP					MOTOR STATUS									
S/MIR-ROR		M/MIRROR	SPRUE	M/BUSH	IJ		RT		MD		E(CP)		IU	
TEMP	120.0	120.0	50.0	50.0	XOL(%)									
FLOW					TEMP									

SD40E – Example of BD-ROM Condition at Cycle Time 4.4 sec

SCALE : CLAMP FORCE ton PRESSURE kgf/cm²

			CYLINDER TEMP											
MACHINE SERIAL No.			Z15A	Z15	Z4	Z3	Z2	Z1	WATER					
DISC FOR	BD-ROM		SET	300.0	320.0	360.0	360.0	330.0	300.0	70.0	°C			
	120.0 mm		ACT	300.0	320.0	360.0	360.0	330.0	300.0	70.0	°C			
STAMPER	ID	mm	FILLING											
	OD	mm	5TH 4TH 3RD 2ND 1ST					STAGES			5V-4P			
	THICK	mm	POS	4.00	5.00	7.00	10.00	22.00	FILL.PRES	2230	kgf/cm ²			
	SUCTION	kPa	VEL	30.0	60.0	100.0	125.0	70.0	FILL.TIME	2.00	sec			
	No.								HOLD VEL	150.0	mm/sec			
MOLD	TYPE	Axxicon	7TH 6TH				HOLD PRESSURE							
	No.		TIME			sec	4TH 3RD 2ND 1ST							
	CAVITY	mm	POS			mm	TIME	0.00	0.00	0.15	0.05	sec		
RESIN	NAME	Makrolon	VEL				mm/s	PRESS	0	0	300	400	kgf/cm ²	
	GRADE	OD2015	PLASTICIZING											
SCREW	TYPE		MODE	Pull Back			Slow Down		Plast End	Pull Back				
	DIAMETER	mm	SHARP	POS	0.00	mm	POS	10.00	27.50	mm	0.00		mm	
NOZZLE	R		R.P	VEL	5.0	mm/s	B.P	30	30	0	kgf/cm ²	5.0		mm/s
	HOLE	mm	POSITION				REV	250	250	80	rpm			
S/SIDE AIR BLOW	PRESS	MPa	INJECTION DETAIL											
	FLOW	rev/OP	INJECTION RESPONSE				UNIT RETRACT		FILL DELAY		PLAST DELAY			
M/SIDE AIR BLOW	PRESS	MPa	STANDARD		HELD ADVANCED		0.00		0.00		sec			
	FLOW	rev/OP	HOLD-PRESS RESPONSE		DELAY	OPE	COOLING		START UP					
NOZZLE AIR BLOW	PRESS	MPa	STANDARD		0.00	0.00	sec	2.70		+	0.20		sec	
	FLOW	rev/OP	FILL COUNT START POS		V-P SWITCH	V-P PRESS	INTERVAL		5		shots			
PLATEN	WATER	ON	0.00	mm	POSITION	0	kgf/cm ²	0.00		sec	ON			
			CLAMP FORCE											
CLAMP FORCE	1ST		MODE		2ND 3RD 4TH 5TH									
	5.0	ton	PRESS 1		CLAMP FORCE		40.0	20.0	15.0		ton			
	Chg.TIME	0.01	sec	DELAY TIME		CLAMP TIME		1.00	0.50	50.00	sec			
	CLAMP CONF	80	%	0.12		sec	CHANGE TIME		0.02	0.02		sec		
INT.PL.DISTANCE		mm												
MOLD TEMP				MOTOR STATUS										
S/MIRROR	M/MIRROR	SPRUE	M/BUSH	IJ	RT	MD	E(CP)	IU	U					
TEMP	90.0	90.0	40.0	40.0	XOL(%)									
FLOW					TEMP									

SD40E – Example of BD-RE Condition at Cycle Time 4.4 sec

SCALE : CLAMP FORCE ton PRESSURE kgf/cm²

			CYLINDER TEMP										
MACHINE SERIAL No.			Z15A	Z15	Z4	Z3	Z2	Z1	WATER				
DISC FOR	BD-RE		SET	310.0	330.0	360.0	360.0	330.0	300.0	70.0	°C		
	120.0 mm		ACT	310.0	330.0	360.0	360.0	330.0	300.0	70.0	°C		
STAMPER	ID	mm	FILLING										
	OD	mm	5TH 4TH 3RD 2ND 1ST					STAGES			5V-4P		
	THICK	mm	POS	2.00	3.00	5.00	9.00	22.00	FILL.PRES	2230	kgf/cm ²		
	SUCTION	kPa	VEL	20.0	50.0	100.0	125.0	80.0	FILL.TIME	2.00	sec		
	No.								HOLD VEL	150.0	mm/sec		
MOLD	TYPE	Axxicon	7TH 6TH				HOLD PRESSURE						
	No.		TIME			sec	4TH 3RD 2ND 1ST						
	CAVITY	mm	POS			mm	TIME	0.00	0.00	0.15	0.05	sec	
RESIN	NAME	Makrolon	VEL				mm/s	PRESS	0	0	300	400	kgf/cm ²
	GRADE	OD2015	PLASTICIZING										
SCREW	TYPE		MODE	Pull Back		Slow Down		Plast End		Pull Back			
	DIAMETER	mm	SHARP	POS	0.00	mm	POS	10.00	27.50	mm	0.00	mm	
NOZZLE	R		R.P	VEL	5.0	mm/s	B.P	30	30	0	kgf/cm ²	5.0	mm/s
	HOLE	mm	POSITION				REV	250	250	80	rpm		
S/SIDE AIR BLOW	PRESS	MPa	INJECTION DETAIL										
	FLOW	rev/OP	INJECTION RESPONSE				UNIT RETRACT		FILL DELAY		PLAST DELAY		
M/SIDE AIR BLOW	PRESS	MPa	STANDARD		HELD ADVANCED		0.00		0.00		sec		
	FLOW	rev/OP	HOLD-PRESS RESPONSE		DELAY	OPE	COOLING		START UP				
NOZZLE AIR BLOW	PRESS	MPa	STANDARD		0.00	0.00	sec	2.70		+	0.20	sec	
	FLOW	rev/OP	FILL COUNT START POS		V-P SWITCH	V-P PRESS	INTERVAL		5		shots		
PLATEN	WATER	ON	0.00	mm	POSITION	0	kgf/cm ²	0.00	sec	ON			
			CLAMP FORCE										
1ST			MODE		2ND		3RD		4TH		5TH		
CLAMP FORCE	5.0	ton	PRESS 1		CLAMP FORCE		40.0	20.0	15.0			ton	
Chg.TIME	0.01	sec	DELAY TIME		CLAMP TIME		1.00	0.50	50.00			sec	
CLAMP CONF	80	%	0.12		CHANGE TIME		0.02	0.02	0.02			sec	
INT.PL.DISTANCE		mm											
MOLD TEMP				MOTOR STATUS									
S/MIRROR	M/MIRROR	SPRUE	M/BUSH	IJ	RT	MD	E(CP)	IU	U				
TEMP	106.0	105.0	50.0	50.0	XOL(%)								
FLOW					TEMP								

Typical value

These values are typical values only. Unless explicitly agreed in written form, they do not constitute a binding material specification or warranted values. Values may be affected by the design of the mold/die, the processing conditions and coloring/pigmentation of the product. Unless specified to the contrary, the property values given have been established on standardized test specimens at room temperature.

General

The manner in which you use and the purpose to which you put and utilize our products, technical assistance and information (whether verbal, written or by way of production evaluations), including any suggested formulations and recommendations, are beyond our control. Therefore, it is imperative that you test our products, technical assistance and information to determine to your own satisfaction whether our products, technical assistance and information are suitable for your intended uses and applications. This application-specific analysis must at least include testing to determine suitability from a technical as well as health, safety, and environmental standpoint. Such testing has not necessarily been done by us. Unless we otherwise agree in writing, all products are sold strictly pursuant to the terms of our standard conditions of sale which are available upon request. All information and technical assistance is given without warranty or guarantee and is subject to change without notice. It is expressly understood and agreed that you assume and hereby expressly release us from all liability, in tort, contract or otherwise, incurred in connection with the use of our products, technical assistance, and information. Any statement or recommendation not contained herein is unauthorized and shall not bind us. Nothing herein shall be construed as a recommendation to use any product in conflict with any claim of any patent relative to any material or its use. No license is implied or in fact granted under the claims of any patent.



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