TOPAS®

Cycloolefin Copolymer (COC)

OPTICAL

TOPAS

Advanced Polymers

Topas Advanced Polymers

Effective January 1, 2006, the global COC business has been sold from Ticona/Celanese to the Japanese companies Daicel and Polyplastics and transfered into a new entity with the name Topas Advanced Polymers. The new company is located in Frankfurt/Germany and Florence/USA and has about 100 people working in Research & Development, Marketing & Sales, Production and Administration.

The History of TOPAS COC started in the early 90s at corporate research of Hoechst AG. In a new developed process first Norbornene will be synthesized from Dicyclopentadiene and Ethylene. In a second copoly-merisation step with Etylene using Metallocene-Catalysts the final product Cyclic Olefin Copolymer is generated. The TOPAS COC production plant in Oberhausen/Germany went on stream in year 2000 with an annual capacity of 30,000 tons.

Topas Advanced Polymers is producing and marketing cyclic olefin copolymers under its trademarks TOPAS® COC and Crystal Dew® and a bi-cyclic olefin Norbornene.

* TOPAS® is a registered trademark of Topas Advanced Polymers GmbH in Germany, the U.S. and other countries.

Contents

1. TOPAS Cyclic Olefin Copolymer (COC)

Application of TOPAS in Optical Products

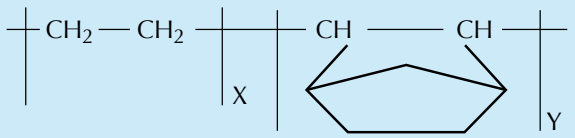
TOPAS is the brand name of the cyclic olefin copolymer manufactured by Topas Advanced Polymers GmbH, and it is an amorphous transparent copolymer. The highly transparent resin also possesses excellent properties in terms of low birefringence, low water absorption, and high stiffness that are important in optical components.

High transparency	Light transmittivity = 91 %
Excellent optical properties	Low birefringence, high Abbe number
Low moisture absorption	Dimensional stability, stable optical properties
Low specific gravity	Specific gravity = 1.02
High heat resistance	Tg of up to 178 °C
High flowability	Precision molding, excellent mold transferability

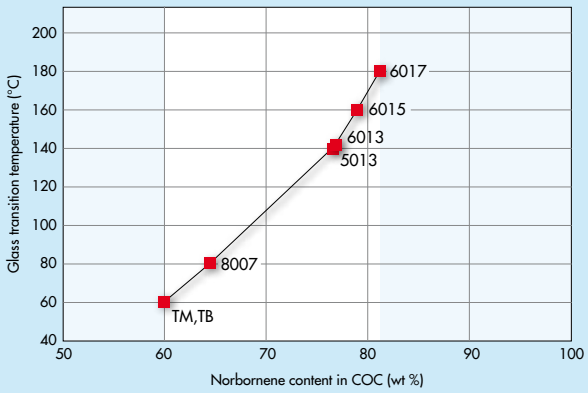
Applications
Lenses for mobile telephone camera
Digital still camera lenses
Printer LBP F0 lenses
CD, DVD pick up lenses
LED lenses
Light guide panels for LCD
Other optical components

TOPAS is a cyclic olefin copolymer (COC) copolymerized from norbornene and ethylene using a metallocene catalyst. Differing from conventional crystalline polyolefins typified by polyethylene (PE) and polypropylene (PP), it is an amorphous transparent copolymer prossessing a cyclic olefin structure.

TOPAS COC – A New Class of Amorphous Thermoplastics



Copolymer Composition and Heat Resistance



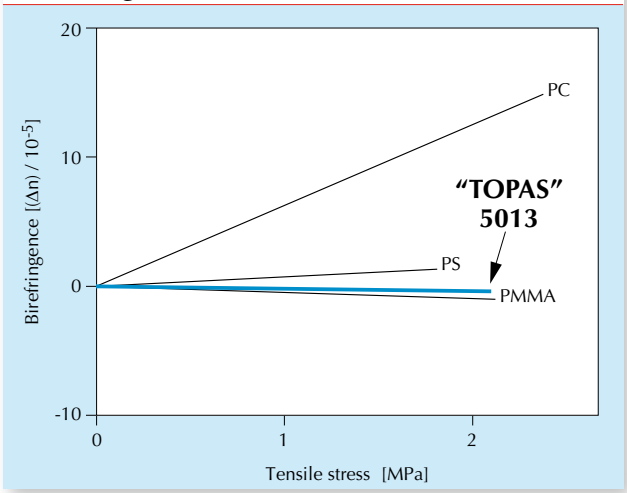
2. TOPAS Excellent Properties for Optical Components

Excellent Optical Properties

	Units	TOPAS (5013LS-01)	PC	PMMA
Total light transmittivity	%	**91.2**	87-89	91-92
Refractive index	–	**1.533**	1.59	1.49
Abbe No.	–	**56**	30-31	57-58
Birefringence	nm	**< 20**	< 65	< 20
Photoelastic coefficient	10^{-12}/Pa	**-2 to -7**	66 to 70	-4.5 to -4.8

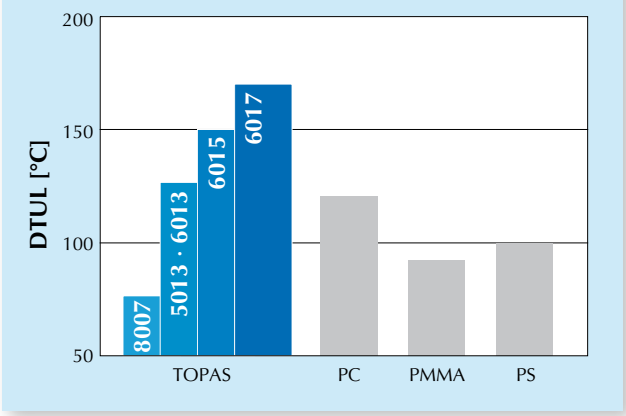
TOPAS is an optical plastic material that has a high light transmittivity over the entire spectrum, as well as a high Abbe number and low birefringence.

Stress Birefringence of various plastics (Birefringence as a function of tensile stress)



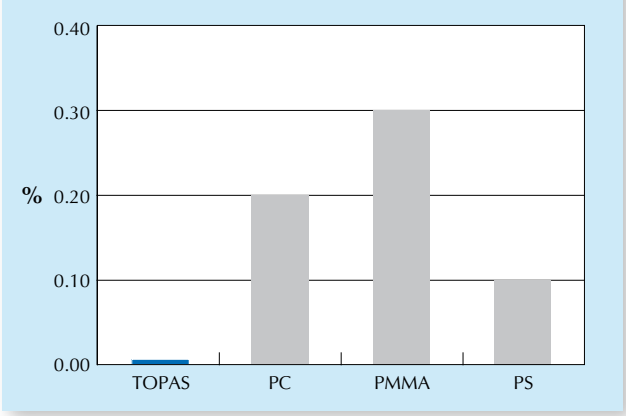
Because of its aliphatic structure and the low optical anisotropy associated with this type of structure, TOPAS has inherently low birefringence, as well as a low stress optical constant.

Heat Resistance



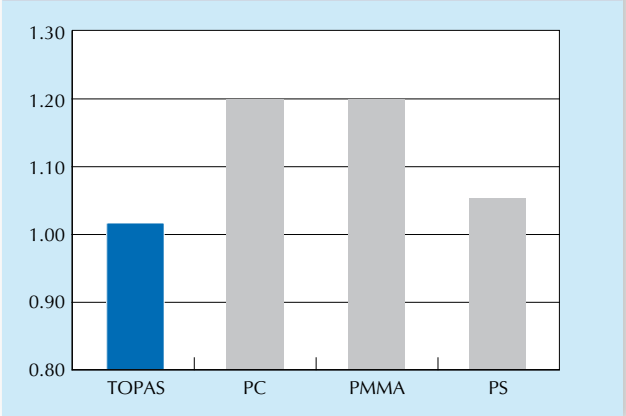
The TOPAS product line covers a wide range of heat resistance temperatures. The maximum heat deflection under load is 170 °C (glass transition temperature = 178°C).

Low Water Absorption (24 h immersion in water at 23 °C)



The water absorption is only 0.01 %, which is a very low value. Optical properties and product dimensional stability under high humidity environments is excellent.

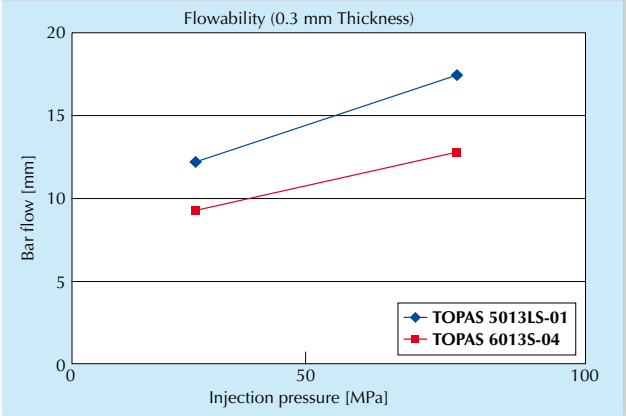
Low Specific Gravity



The specific gravity of TOPAS is 1.02, which is approximately 20 % lower than other optical plastics such as PC and PMMA.

Accordingly, the weight of optical components can be kept low.

High Flow



The melt viscosity of TOPAS is low, providing excellent flowability. Therefore, thin wall molding is possible and good transfer of fine designs and patterns is possible. The optical grade 5013LS-01 in particular has thin wall flowability unprecedented in other optical resins.

3. Grades for Optical Components

Grade	Application
5013LS-01	Optical lenses
5013L-10	Thin wall light guide panels / General optical components
6013S-04	General optical components / optical film
6015S-04	Optical components in high heat resistant applications

Physical Properties

Property	Unit	Test method	5013LS-01	5013L-10	6013S-04	6015S-04
Volume flow index MVR (260 °C/2.16 kg)	ml/10 min.	ISO 1133	54	48	14	4
Density	g/cm³	ISO 1183	1.02	1.02	1.02	1.02
Water absorption (23 °C/24 h emersion)	%	ISO 62	<0.01	< 0.01	< 0.01	< 0.01
Mold shrinkage (mold T = 60 °C, 2mm)	%	–	0.4-0.7	0.4-0.7	0.4-0.7	0.4-0.7
Mechanical properties ISO 291-23/50 (measured under standard conditions)						
Tensile strength	MPa	ISO 527-2/1A	45	46	63	60
Elongation at break	%	ISO 527-2/1A	2.0	1.7	2.7	2.5
Tensile modulus	MPa	ISO 527-2/1A	3,300	3,200	2,900	3,000
Charpy impact strength (notched)	kJ/m²	ISO 179/1eA	1.3	1.6	1.8	1.6
Thermal properties						
DTUL HDT/B (0.45 MPa)	°C	ISO 75	125	127	130	150
DTUL HDT/B (1.82 MPa)	°C	ISO 75	117	–	119	135
Glass transition temperature	°C	ISO 11357-1,-2,-3	128	134	138	158
Coefficient of linear thermal expansion	°C⁻¹	ISO 11359 parts 1 and 2	$0.6 \cdot 10^{-4}$	$0.6 \cdot 10^{-4}$	$0.6 \cdot 10^{-4}$	$0.6 \cdot 10^{-4}$
Flammability						
UL Flammability rating	Class	UL 94	–	–	HB (1.6 mm)	HB (1.6 mm)
Optical properties						
Light transmittivity (2 mm)	%	ISO 13468-2	91.2	91.4	91	91
Refractive index	–	–	1.53	1.53	1.53	1.53
Abbe No.	–	–	56	56	–	55

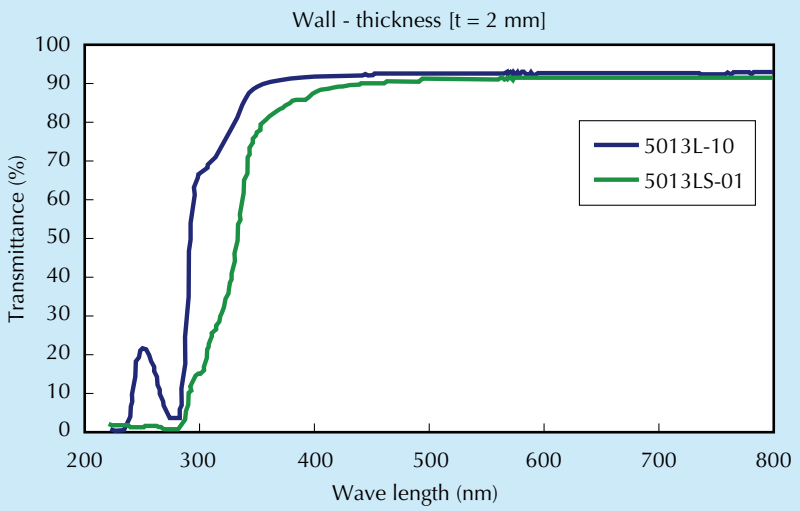
The above values are representative values and not guaranteed values for quality.

4. Optical Design Data

Total Light Transmittance

TOPAS allows light to pass from the near ultraviolet spectrum, through the visible spectrum, to near infrared wavelengths.

Transmittance of 5013LS-01,5013L-10



Refractive Index

TOPAS shows little variation in refractive index over temperature.

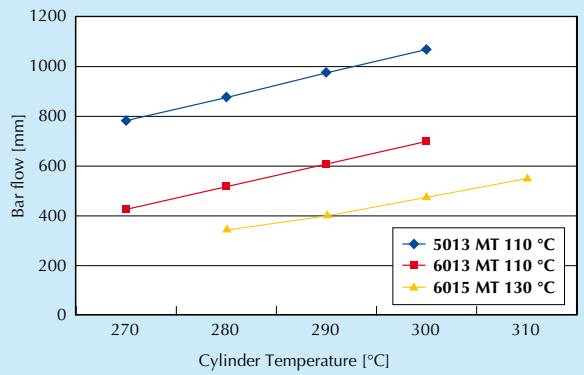
5013LS-01 refractive index (wavelength/temperature)

Temp (°C)	g line 435.8 nm	F line 486.1 nm	e line 546.1 nm	d line 587.6 nm	C line 656.3 nm	LD line 780 nm
-40 °C	1.5505	1.5453	1.5407	1.5386	1.5357	1.5323
-20 °C	1.5488	1.5436	1.5390	1.5369	1.5340	1.5306
-10 °C	1.5480	1.5427	1.5382	1.5360	1.5332	1.5298
0 °C	1.5471	1.5419	1.5374	1.5352	1.5323	1.5290
10 °C	1.5461	1.5409	1.5364	1.5341	1.5313	1.5280
25 °C	1.5451	1.5399	1.5354	1.5332	1.5304	1.5270
40 °C	1.5439	1.5386	1.5342	1.5318	1.5290	1.5258
60 °C	1.5423	1.5369	1.5325	1.5301	1.5274	1.5241
80 °C	1.5403	1.5350	1.5306	1.5283	1.5255	1.5222

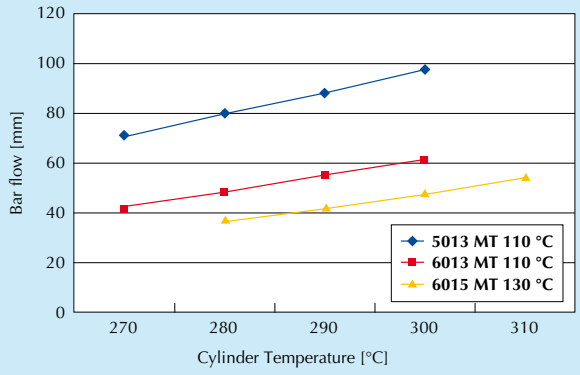
The above values are representative values and not guaranteed values for quality.

5. Injection Molding for TOPAS

TOPAS Flowability, 2 mm thickness

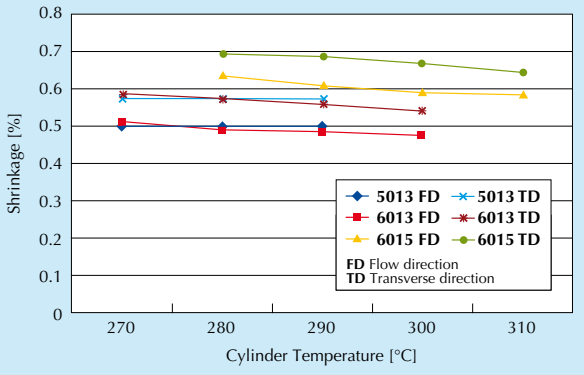


TOPAS Flowability, 0.5 mm thickness



All TOPAS grades provide good flowability, especially 5013LS-01 shows excellent flow properties.

Mold shrinkage



Test sample: 2 mm thickness flat plate

Gate size: 4 mm · 2 mm (side gate)

Molding conditions

Mold temperature		Injection pressure
5013LS-01	110 °C	58.8 MPa (49.0 MPa for 5013)
6013S-04	110 °C	
6015S-04	130 °C	

Typical Molding Conditions for TOPAS

Pre-drying

If high optical surfaces and color is required, pre-drying of TOPAS is recommended prior to molding in order to remove oxygen dissolved in the pellets.

If injection molding is carried out with dissolved oxygen still contained in the resin, it might result in an increase in YI and occurrence of burning.

Nitrogen purging

TOPAS is a very transparent material but if it is injection molded in the presence of oxygen, carbonization, burning, and color change may result due to oxidation. Please make sure to carry out nitrogen purging in order to prevent oxidation.

Resin change

When injection molding TOPAS, we recommend using a dedicated machine to prevent contamination. If resin change is unavoidable, please remove the screw for cleaning.

The melt viscosity of 5013LS-01,5013L-10 is particularly low. Therefore the previous material may not properly be removed with standard purging and this causes contamination.
Please note that if powders of other resin is left in the hopper dryer or the supply line of pellets, it is the cause of contamination.

Handling during stoppages

In order to prevent oxidation, keep the cylinder packed with resin while carrying out nitrogen purging, and maintain the entire cylinder at 10-20 °C above the glass transition temperature (Tg) of each grade.

Typical Molding Conditions for TOPAS

Grade		5013LS-01	5013L-10	6013S-04	6015S-04
Drying conditions		100 °C · 6 h	100 °C · 6 h	100 °C · 6 h	100 °C · 6 h
Cylinder temperature [°C]	Nozzle	250~280	250~280	250~280	270~300
	Metering	250~280	250~280	250~280	270~300
	Compression	240~280	240~280	240~280	260~300
	Feed*	220~280	220~280	220~280	230~300
Mold temperature [°C]		105~115	110~120	110~120	120~130
Injection pressure [MPa]		30~100	50~120	50~120	50~120
Injection speed [mm/s]		30~100	30~100	50~100	50~100
Back pressure [MPa]		5~10	5~10	5~15	5~15
Screw rotation [rpm]		50~150	50~150	50~150	50~150

* Set the temperature low if the feed zone is long
Set higher feed zone temperature for small injection machine with short feed screw

The molding conditions in the above table are guidelines for optical parts.
Adjust them according to the molding machine and the product shape. If you need conditions for general injection molding parts please refer to our standard broshure.

Optical Applications

Innovative Solutions with glass-like Advantages

IMPORTANT

The properties of molded articles can be affected by a variety of factors,including choice of molding material,additives,part design, molding conditions ,and exposure to the environment. Customers should take responsibility as to the suitability of a particular material or part design, for a specific application. In addition,before commercializing a product that incorporates plastic parts,customers should take the responsibility of carrying out performance evaluations.Our company's products are not intended for use in medical and dental implants.Unless specified,the numerical values given in this literature are for reference purposes only and they do not indicate the necessary foundations for part design. Without fail,please follow the molding and other procedures explained in this literature.This literature does not guarantee specific properties for our company's products.Please take the responsibility of verifying industrial property rights of third parties.

NOTES TO USERS

- The property values given in this literature are measured values or representative values obtained from samples under various prescribed standards and test methods.
- This literature was compiled base on our company's accumulated experience and laboratory data,and the data shown here may not be applicable as is to parts used under different conditions.
  Accordingly,these contents do not guarantee that application is possible as is to your company's usage conditions.Regarding utilization,your company must make the final decisions.
- Your company should consider the technology rights and usage durability/potentiality concerning examples of practical use and application introduced in this literature.
  Furthermore,we do not assume our company's materials will be used in medical and dental implant applications and we do not recommend these applications.
- Regarding implementation of appropriate operations,please refer to the “Technical Catalogue” for the material suited to the particular objective.
- Please refer to the corresponding material safety data sheet (MSDS)for the material or grade employed regarding safe handling of our company's materials.
- The contents of this literature were compiled based on literature,information,and data available at that point in time. We reserve the right to revise without notice based on new knowledge.
- If there are any uncertainties regarding our company's products and explanatory literature,or the precautions referred to here,by all means please inquire to our company and consult with us.

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