TOPAS®

Thermoplastic Olefin Polymer of Amorphous Structure (COC)

TOPAS® Cyclic Olefin Copolymer

Polyplastics

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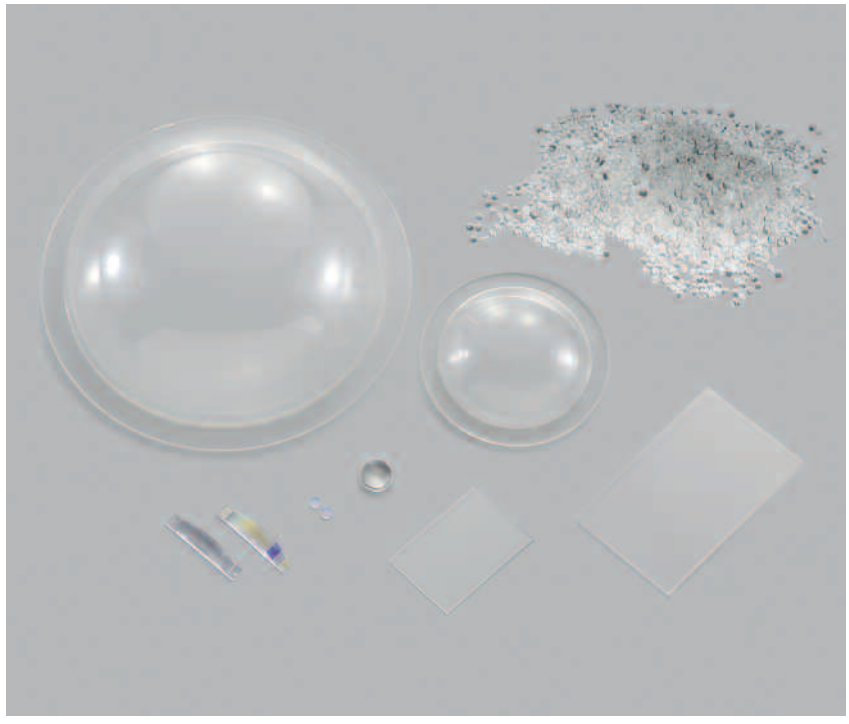
Cyclic Olefin Copolymer(COC)

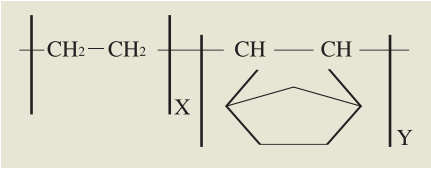
Transparent copolymer with excellent optical properties

- high transparency
  - ▶high light transmission of 91%
- excellent optical properties
  - ▶low birefringence, high abbe's number
- low specific gravity
  - ▶specific gravity of 1.02
- high heat resistance ▶Tg of up to 180℃
- low water absorption
  - ▶dimensional stability and stable optical characteristics
- excellent water vapor barrier properties
  - ▶able to preserve sensitive products
- low dielectric constant, low dielectric loss
  - ▶low loss properties for high frequency signals
- FDA-approved
  - ▶compatible with pharmaceutical and food applications
- applicable for various sterilization methods
  - ▶autoclavable, γ rays, EOG
- High stiffness/strength



TOPAS® is the trade name of a cyclic olefin copolymer (COC) developed by Ticona, and as opposed to crystalline polyolefins as represented by conventional polyethylene (PE) and polypropylene (PP), it is an amorphous transparent copolymer possessing a cyclic olefin structure.

TOPAS® is a cyclo olefin copolymer (COC) copolymerized from norbornene and ethylene using a metallocene catalyst. A cyclic olefin polymer (COP) type exists that is polymerized through metathesis ring opening, but TOPAS® COC possesses excellent properties from the perspective of refractive index, and low moisture, and high rigidity, which are important properties when it is used in optical parts.



TOPAS® has been evaluated highly in the market as a resin with optical properties comparable with PMMA (polymethyl methacrylate, acrylic resin), superior heat resistance to PC (polycarbonate), and superior dimensional stability to PMMA and PC. Furthermore, is a material that is suitable for modifier applications for existing materials, where it can improve the water vapor barrier, increase rigidity, enhance heat resistance, and make materials easier to cut. Here, application activities are underway in the packaging materials sector.

Major applications

Optical applications such as lenses, liquid crystal display light guide panels, and optical films

Polyethylene,polypropylene modifier applications in the packaging materials sector

Medical and diagnostic equipment sector

Electronic device sector

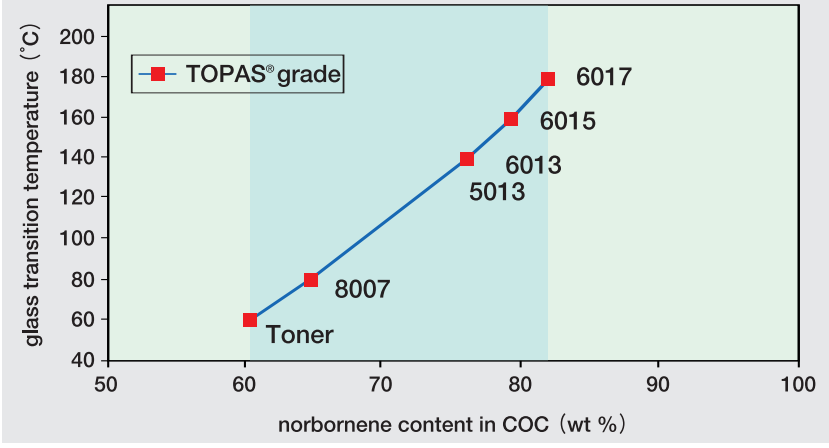
Various other,diverse industrial sectors

Grades

Through its characteristic molecular structure and superior catalyst technology, TOPAS® offers a wider range of grade variations in terms of flow properties and heat resistance, and grades with different heat deflection temperature (HDT/B) can currently be offered as basic grades. Comonomer content determines the heat deflection temperature and TOPAS® COC grades with high cyclic olefin content have higher heat resistances. Among these, TOPAS® grade 5013 has the highest flowability and TOPAS® grade 6017 the highest heat resistance.

Grades	Basic grade characteristics
8007	Heat deflection temperature (HDT/B) = 75℃ Water adsorption is small and barrier properties are exceedingly good, making this grade particularly suitable for package applications for products that dislike moisture. Grade 8007 has lower coefficient of elasticity and larger elongation compared with other TOPAS® COC grades.
6013	Heat deflection temperature (HDT/B) = 130℃. Due to its high transparency, low levels of eluates, superior chemical resistance, and high heat deflection temperature, this grade is suitable for products such as pharmaceutical packaging and diagnostic equipment.
6015	A similar grade to 6013. However, heat deflection temperature (HDT/B) = 150℃. This is a temperature that cannot be achieved with many other amorphous polymers.
5013	Heat deflection temperature (HDT/B) = 130℃. This grade is characterized by its high flowability and superior optical properties. It is suitable for optical components such as lenses and light guide panels where high molded precision is indispensable.
6017	Heat deflection temperature (HDT/B) = 170℃. Possesses the highest heat resistance among cyclic olefin-type resins.

Fig.1：Copolymer composition and heat resistance



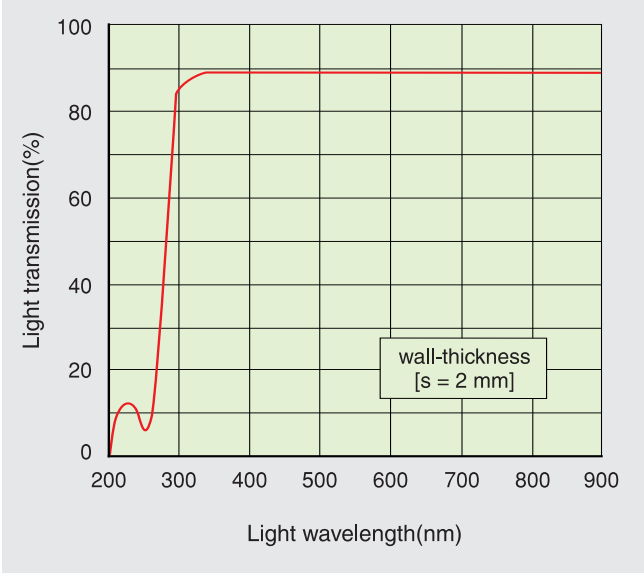
Optical properties

TOPAS® possesses optical properties comparable with PMMA and superior heat resistance to PC. Moreover, it possesses excellent dimensional stability due to the fact that it absorbs almost no moisture. These attributes have earned the resin a high evaluation in the optical market sector

Transmission and Refractive Index

Light transmission in the visible region is an important optical property for optical applications such as lenses, prisms or optical storage media but is not the only important optical property. The high transparency of TOPAS® COC in the visible and near ultraviolet regions (see Fig. 2), coupled with a refractive index of 1.53 (TOPAS® 5013) makes the polymer attractive for optical components. Moreover, the chromatic aberration of TOPAS® COC, evidenced by a high Abbe number of 58 for TOPAS® 5013, is very low. TOPAS® COC is, therefore, suitable for the production of high-quality optical components for cameras and office machines.

Fig.2：Light transmission of TOPAS® 6015 as a function of wavelength



Stress-optical constant and birefringence

Because of its aliphatic structure and the low optical anisotropy associated with this type of structure, TOPAS® COC has inherently low birefringence, as well as a low stress optical constant. Fig. 3 shows the effect of applied tensile stress on the birefringence of various plastics. Table 1 shows that the stress-optical constant of TOPAS® COC is in the same range as that for PMMA but only around one-tenth of the value for PC. The advantageous optical properties of TOPAS® COC resin and its very low moisture absorption, coupled with its superior flowability, enable high precision molding of very thin products with precision patterns such as compact light guide panels.

Fig.3：Stress birefringence of various plastics (birefringence as a function of tensile stress)

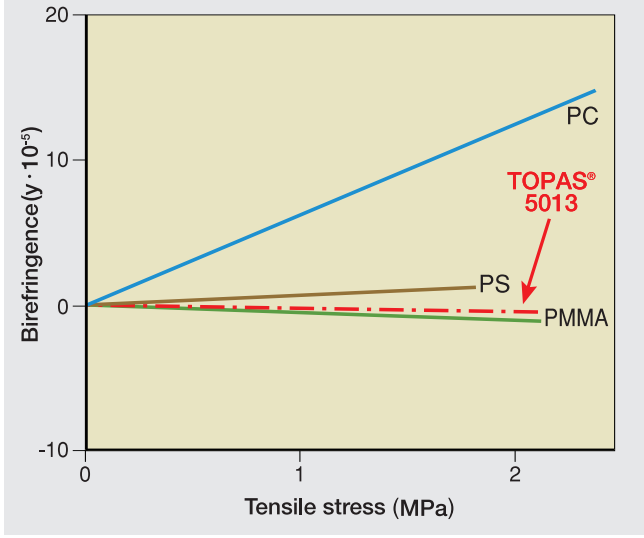


Table1：Excellent optical properties

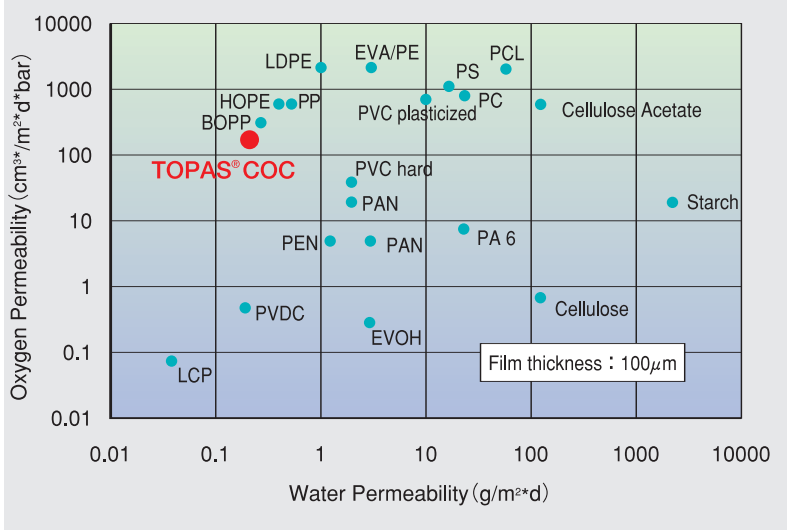
	Unit	TOPAS® 5013	PC	PMMA
Light transmission※	%	91	87-89	91-92
Refractive Index	—	1.53	1.59	1.49
Abbe number	—	58	30-31	57-58
Birefringence	nm	＜20	＜65	＜20
Stress Optical Constant	$10^{-12}Pa^{-1}$	−2 to −7	66 to 70	−4.5 to −4.8
Saturated Water absorption	%	0.01	0.2	0.3

※Testing Method: ISO 13468-1

Water Vapor Barrier Properties

TOPAS® possesses a very high water vapor barrier, and development is underway in the medical and packaging fields.

Fig.4 : Barrier Properties of COC



Chemical resistance, sterilizability

TOPAS® displays excellent resistance towards water-soluble chemicals, acids, alkalis, and polar organic substances. Furthermore, it is compatible with various sterilizing processes. Moreover, TOPAS® is a very safe materials, and basic grades are registered under the U.S. FDA and U.S. Pharmacopoeia XXIII,Class VI. Interest is therefore growing in the medical・diagnostic device sector.

Table2 : Compatible with various sterilization techniques

Compatible with various sterilization techniques							
TOPAS®	Hot steam			Hot air	EOG	High-energy radiation	
	121℃	134℃	143℃			gamma	electron
8007	×	×	×	×	○	○	○
5013	○	×	×	○	○	○	○
6013	○	×	×	○	○	○	○
6015	○	○	○	○	○	○	○

○: Usable △: Usable with care ×: Not usable

Table3 : Chemical resistance (under Room Temp.)

	TOPAS®	PC	PMMA	PS	PVC
Acids	○	○	○	○	○
Alkalis	○	×	○	○	△
Alcohols	○	△	△	△	○
Ketones	○	×	×	×	×
Esters	○	×	×	×	×
Chlorinated solvents	×	×	×	×	×
Aromatic solvents	×	×	×	×	×
Gasoline	×	△	△	×	×
Oils	×	○~△	○	×	△

○: Usable △: Usable with care ×: Not usable

FDA registered
- Food Contact Notification(FCN NO.75)
- Drug Master File-DMF12132
- Device Master File-MAF1043

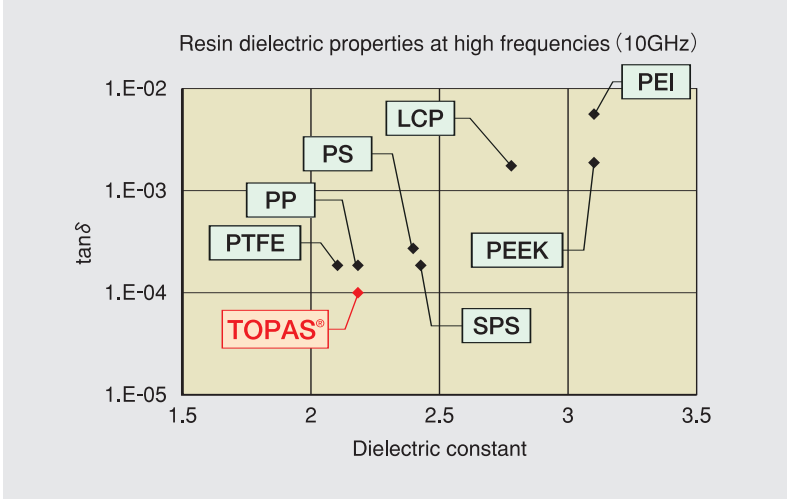
U.S. Pharmacopoeia XXIII,Class VI
- Acute systemic test-pass
- Intracutaneous test-pass
- Implant test-pass
- Cytotoxicity-none observed
- Hemolysis-non hemolytic

Registered grades
- 8007,5013,6013,6015

Electrical properties

TOPAS® exhibits excellent electrical properties at high frequencies, and development of antennae and other electronic device applications is anticipated.

Fig.5：Low dielectric and low loss in GHz region



Physical properties

Property of TOPAS grades

				Grades				
		Unit	Test Method	8007	6013	6015	5013	6017
Property	Volume flow index MVR (260℃/2.16kg)	ml／10 min	ISO 1133	32	14	4	48	1.5
	Volume flow index MVR (HDT/B+115℃/2.16kg)	ml／10 min	ISO 1133	2	6	5	25	5
	Density	g／cm³	ISO 1183	1.02	1.02	1.02	1.02	1.02
	Water absorption,immersion @23℃	%	ISO 62	0.01	0.01	0.01	0.01	0.01
	Water permeability @23℃ 85RH%	g・mm/m²・d	DIN 53 122	0.023	0.035	0.035	0.030	0.045
Mechnical Property	Tensile modulus (1mm/min)	MPa	ISO 527 parts 1 and 2	2600	2900	3000	3200	3000
	Tensile strength at break (5mm/min)	MPa		63*	63	60	46	58
	Tensile elongation at break (5mm/min)	%		4.5*	2.7	2.5	1.7	2.4
	Charpy impact strength (unnotched)	kJ/m²	ISO 179/1eU	20	15	15	13	15
	Charpy impact strength (notched)	kJ/m²	ISO 179/1eA	2.6	1.8	1.6	1.6	1.6
	Pencil hardness	—	JIS K5401	HB	HB	HB	F	F
Thermal Property	Glass transition temperature	℃	ISO 11375-2	80	140	160	136	180
	Heat deflection temperature at 0.45MPa	℃	ISO 75 part 1 and 2	75	130	150	127	170
	Heat deflection temperature at 1.80MPa	℃		68	119	135	116	151
Optical Property	Light transmittance	%	ISO 13468-1	91	91	91	91	91
	Refractive index	—	ISO 489	1.53	1.53	1.53	1.53	1.53
	Abbé number	—	—	—	—	—	58	—

As the values above have not been fully verified statistically, they may be subject to change. Do not use them for specifications.

* test speed 50mm/min

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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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