About Polyacetals

GLOBAL POLYACETAL CO., LTD.
Technology Division
POM Development Department

Iupital™

What is polyacetal?

- ✓ Polyacetal, also known as POM (Polyoxymethylene), exists in two types: a homopolymer composed solely of oxymethylene units, and a copolymer containing partial oxyalkenylene units.
- ✓ It combines excellent mechanical properties, durability, sliding characteristics, chemical resistance, and thermal stability, and is widely used in various industries such as automotive and OA filed.

$$-(CH_2O)_m-$$
homopolymer

$$-(CH_2O)_m-(CH_2CH_2O)_n-$$
copolymer

- ➢ Automotive: Fuel parts

- ➢ Automotive /OA/ and others: Gears

- ➢ Health Care: Inhaler

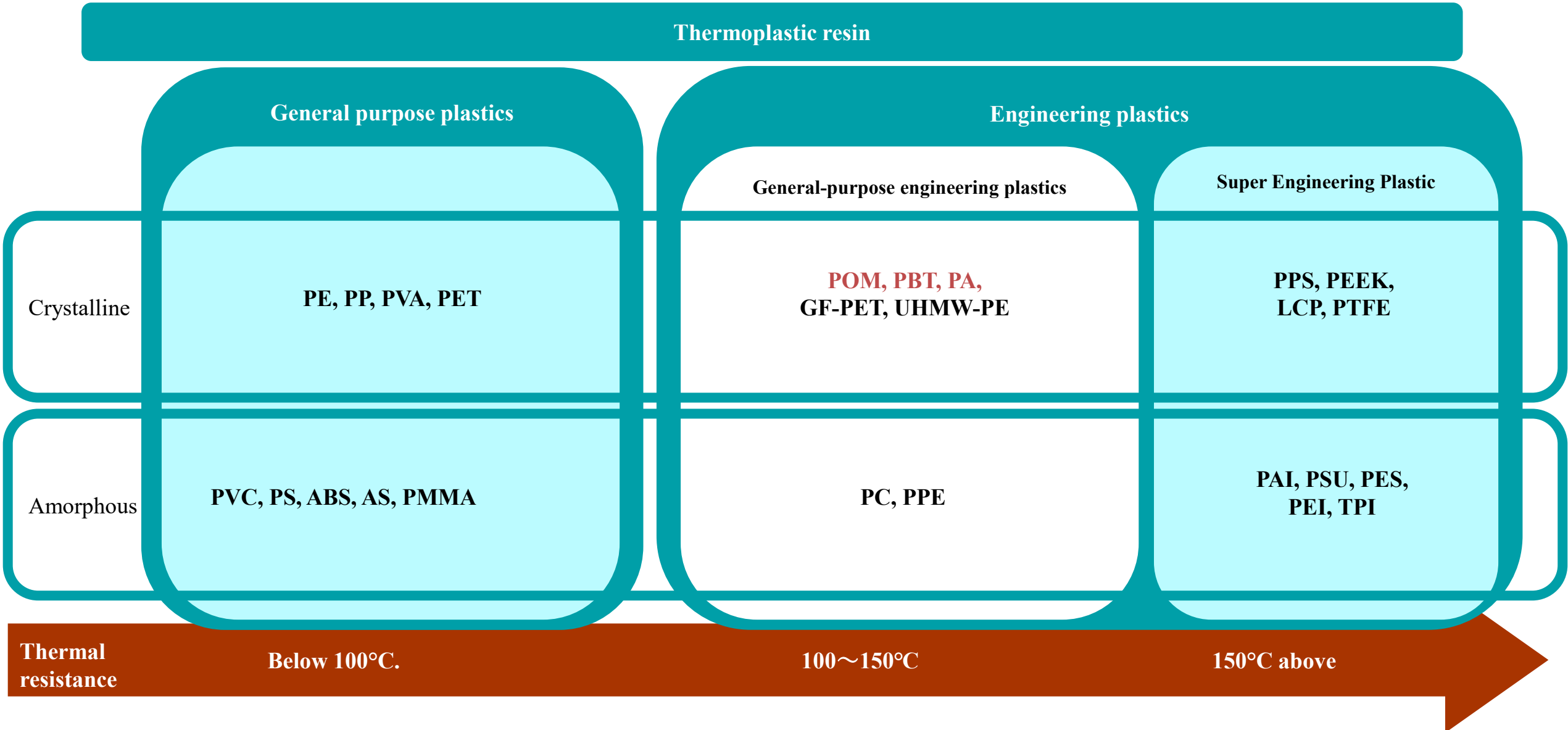
- ➢ Automotive: Safety parts

- ➢ Apparel: Fasteners

- ➢ Housing: Water-related mechanism parts

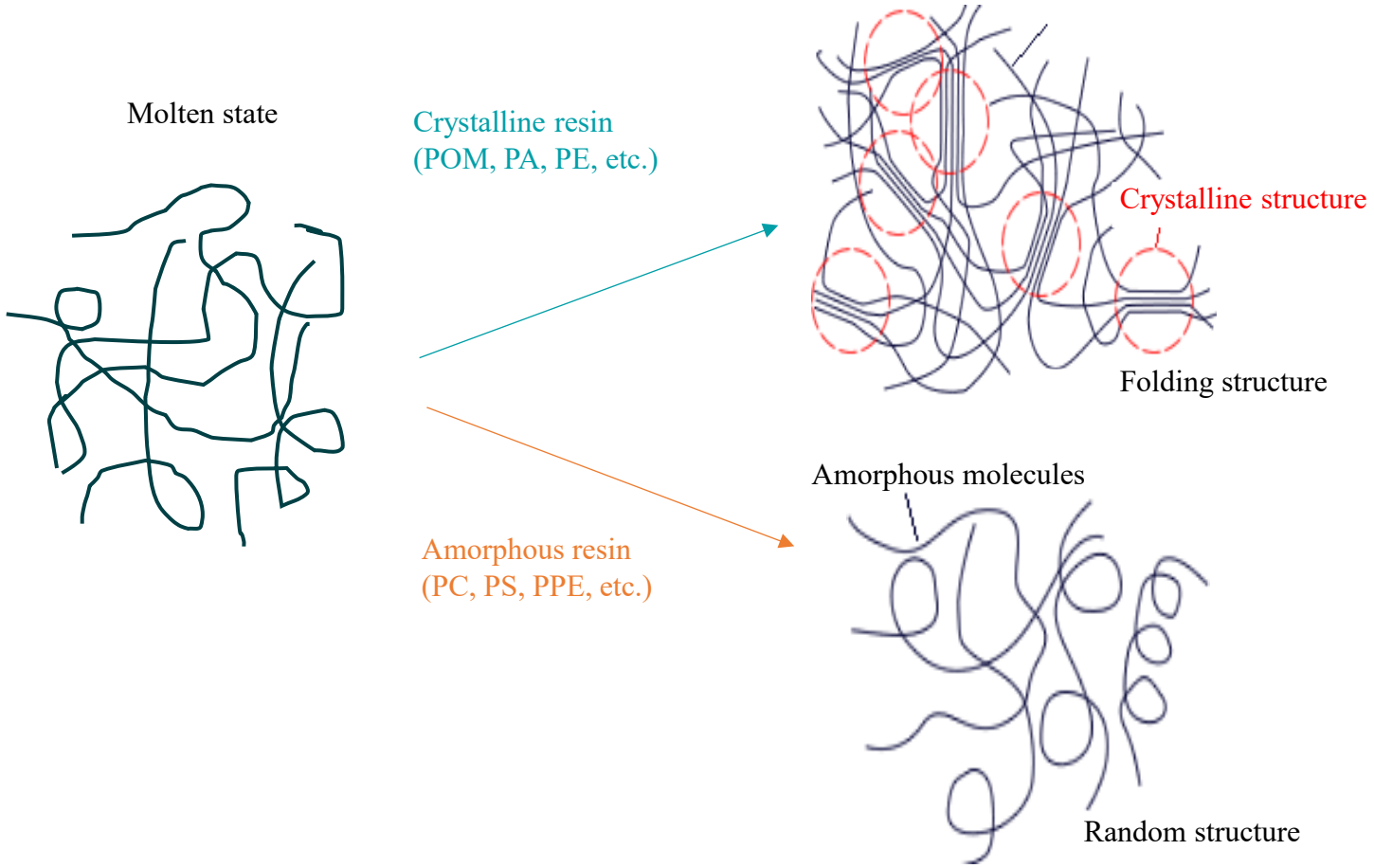
Positioning of POM in Thermoplastics

✓ Polyacetals are classified as crystalline general purpose engineering plastics.



Differences between Crystalline and Amorphous Resins ①

✓ Crystalline resins have molecules arranged in a regular pattern, forming an orderly structure, whereas amorphous resins have molecules arranged in a disorderly manner, resulting in a random structure.

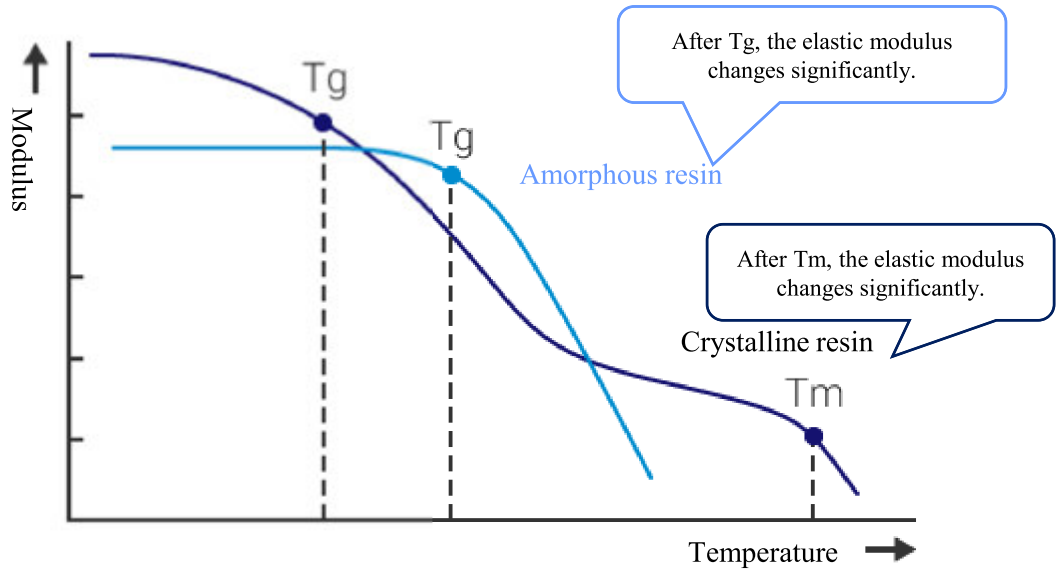


Differences between Crystalline and Amorphous Resins ②

✓ Crystalline and amorphous resins exhibit different properties depending on the presence or absence of crystalline structure.

	Crystalline resin	Amorphous resin
Transparency	Opaque	Clear
Chemical resistance	Excellent	Inferior
Molding shrinkage	Large	Small
Mechanical strength	Excellent strength, rigidity and durability	Excellent flexibility and shock absorbency
Temperature characteristics	Have glass transition and melting points	Glass transition point only

Glass-transition point (Tg) and melting point (Tm).



Characteristics of POM in crystalline general-purpose engineering plastics.

✓ POM has the highest crystallinity in general-purpose engineering plastics.

Advantages of POM

Good friction and wear characteristics

Good cyclic fatigue resistance

High creep resistance

Small temperature dependence of mechanical properties

Excellent chemical resistance (except strong acids)

Disadvantages of POM

Large mold shrinkage

Difficult to make flame retardant

Difficult to bond, paint and print

Inferior in heat resistance compared to other crystalline engineering plastics

Crystalline resin	Crystallinity %	Melting point ℃	Glass transition temperature ℃
POM homopolymer $-(CH_2O)_n-$	60~80	175	-60
POM copolymer $-(CH_2O)_m-(CH_2CH_2O)_n-$	50~60	165	-60
PA6 $-(NH(CH_2)_5CO)_n-$	20~40	220	50
PBT -(CO-  -CO$(CH_2CH_2)_2)_n$-	30~48	225	50

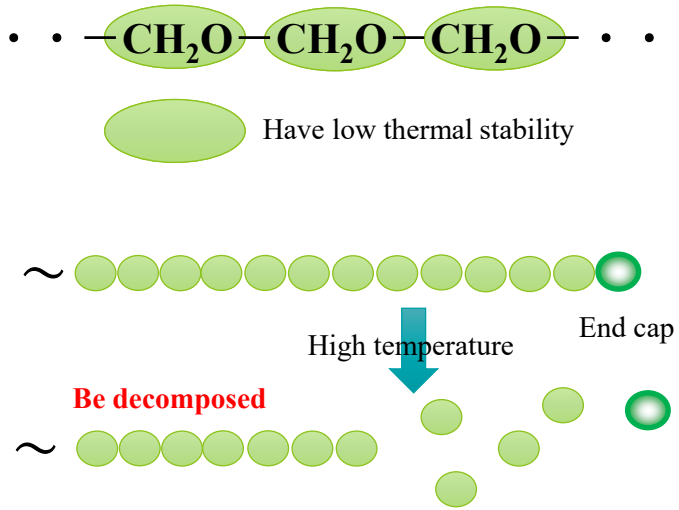
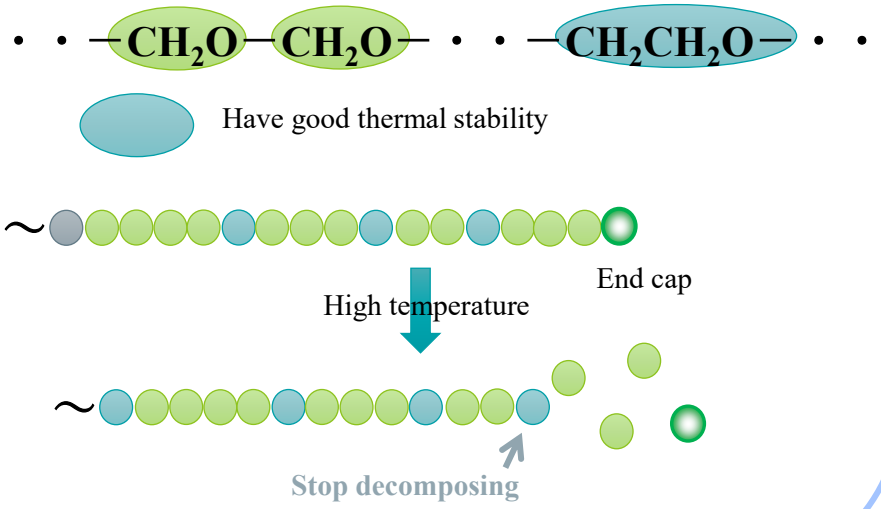
※The above data are representative values, and may differ depending on the material type, measurement method, etc.

※Supplement

- ✓ Because POM has less functional groups and higher crystallinity, it has lower affinity with other resins and compounds and is excellent in wear-friction properties and chemical resistance. (while making it difficult to bond, paint, and print)
- ✓ High crystallinity contributes to excellent fatigue resistance and creep resistance, but results in a larger molding shrinkage rate.
- ✓ Since the glass-transition temperature of POM is low, the inflection point of strength does not appear in the temperature range of normal use, and the temperature dependency of mechanical properties becomes small.
- ✓ Since POM contains a large amount of oxygen-containing elements in its molecules, it is difficult to make it flame retardant.

Differences between POM homopolymers and copolymers

- ✓ Copolymers have excellent thermal stability because they contain thermally stable structures in their molecules.
- ✓ Because of its simpler molecular structure, homopolymers have higher crystallinity and better mechanical properties.

	$-(CH_2O)_m-$ homopolymer	$-(CH_2O)_m-(CH_2CH_2O)_n-$ copolymer
Mechanical properties Examples	crystallinity :60～80% Tensile strength :70 MPa Flexural modulus:2800 MPa	Percent of crystallinity :50～60% Tensile strength :64 MPa Flexural modulus :2400 MPa
Thermal stability Image		

Comparison of Typical Properties with Non-Reinforced Plastics

- ✓ The glass transition temperature of POM is approximately -60°C, so no inflection point in mechanical properties occurs within the temperature range (-40 to 120°C) required for automotive applications and similar uses.
- ✓ Furthermore, it has excellent sliding, chemical and fatigue properties, so it is widely used in gears and other sliding parts.

Items	units	POM (Copolymer)	PA6	PC	PET (Homo)	PBT	m-PPE (PPE-PS)	PP (Homo)
Glass transition point(Tg)	deg.C	-60	50	145	70	50	220	0
Melting point (Tm)	deg.C	165	220	-	250	225	-	160
Density	g/cm3	1.41	1.14	1.2	1.34	1.31	1.1	0.9
Tensile strength	MPa	65	80	62	60	60	50	40
Tensile elongation	%	30	30	120	20	45	30	50
Flexural strength	MPa	90	110	93	83	80	95	50
Flexural modulus	MPa	2600	2700	2300	2500	2300	2500	2000
Charpy notched imapct strength	kJ/m2	5	6	70	3	6	16	10
Molding temperature	deg.C	190-220	250-280	270-300	270-300	250-270	260-290	190-220
Water absorption		○	×	◎	◎	◎	◎	◎
Chemical resistance		◎	◎	×	○	○	×	○
Sliding ability		◎	○	△	○	○	△	△

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Typical applications

Parts: Gear
Excellent gear characteristics due to high sliding characteristics, fatigue resistance and strength.
In addition, a wide variety of greases can be used due to their high chemical resistance.

Parts: Fasteners
High sliding properties, fatigue resistance, and strength minimize snagging during motion, resulting in a long-lasting fastener. Additionally, high water resistance and chemical resistance ensure minimal deterioration during washing..

Parts: Inhauler
High sliding properties ensure smooth operation during use.
It is also effective in improving abnormal noise (rubbing).

Part: Seat belt retractor
The seat belt can be rolled up with less power due to its high slidability.
In addition, because of its excellent wear resistance, creep resistance, and fatigue resistance, it is not likely to deteriorate during long-term use.
By selecting grades, you can use them not only on sliding parts but also where quietness and impact resistance are required.

About Iupital ™

- ✓ The Iupital™ is a high-performance polyacetal produced by its own processing.
- ✓ Since its manufacture and sales began in 1981, we have continued to provide stable, high-quality products.
- ✓ It has a wide range of grade-line up that are suitable for all applications.

Grade classification	Features
General	A general-purpose type that can be used in a wide range of applications.
High viscosity	Suitable for extrusion molding applications. Improved creep resistance and fatigue resistance over the standard.
High flow	Suitable for parts that require fluidity, such as thin-walled molded articles.
High rigidity	Mechanical properties close to homopolymer.
Softness and toughness	Softer than standard and improved impact resistance.
Reinforced	Greatly reinforced mechanical properties with glass fiber, carbon fiber, minerals, etc.
High sliding	The slidability, characteristic of POM, is further improved.
Low VOC	Significantly reduce VOC regulated in the automotive field.
Weather resistance	Suppressing degradation caused by UV.
Conduction and electrification	Electrical resistance is reduced.
Sanitation	Applicable to medical, drinking water, food contact, etc.
High design	Design properties such as matte, metallic etc. are given.

Summary

- Polyacetal, also known as POM (Polyoxymethylene), exists in two types: a homopolymer composed solely of oxymethylene units, and a copolymer containing partial oxyalkenylene units.
- It combines excellent mechanical properties, durability, sliding characteristics, chemical resistance, and thermal stability, and is widely used in various industries such as automotive and OA field.
- Polyacetals are classified as crystalline general purpose engineering plastics.
- POM has the highest crystallinity in general-purpose engineering plastics.
- Copolymer type has excellent thermal stability because it contain thermally stable structures in molecules.
- Homopolymer type has higher crystallinity and better mechanical properties because of its simpler molecular structure.
- The glass transition temperature of POM is approximately -60°C, so no inflection point in mechanical properties occurs within the temperature range (-40 to 120°C) required for automotive applications and similar uses.
- Iupital™ is a high-performance polyacetal produced by its own processing.
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