

『POKETONE™』

- Hyosung Polyketone

Hyosung Corporation
POK Business Unit

I . POKETONE Introduction

POKETONE Definition

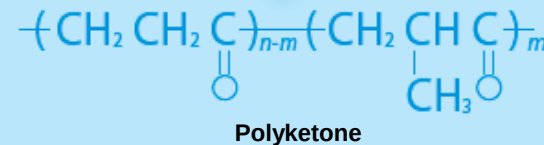
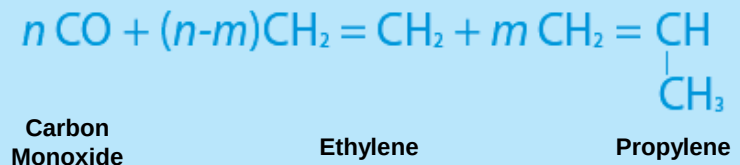
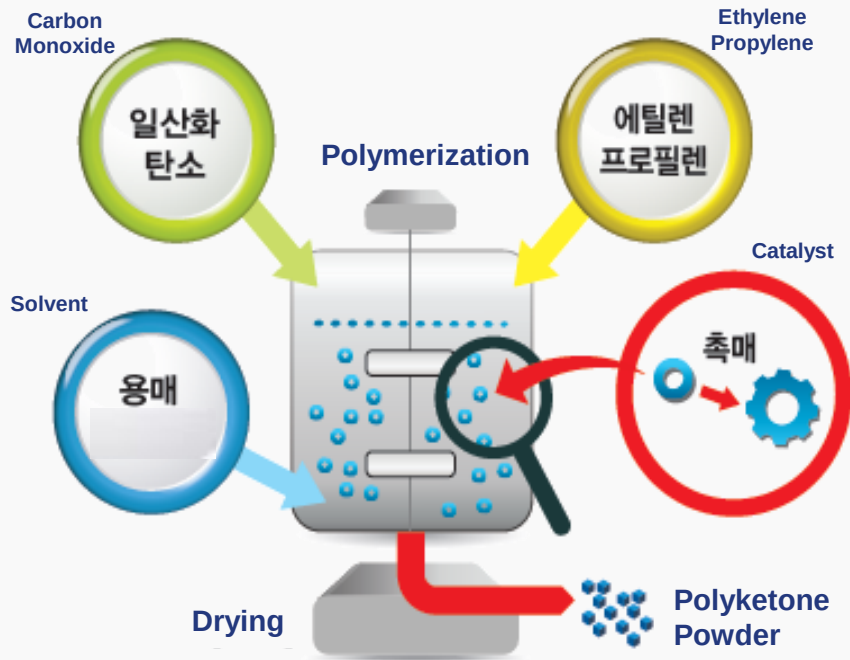
- What is POLYKETONE?

New Green Polymer composed with Carbon Monoxide and Olefins (Ethylene, Propylene)

- What is **POKETONE**?

Brand Name of HYOSUNG Aliphatic Polyketone

Registered its Trademark in 2016 and now on promoting to diverse industries



I. POKETONE Introduction - PORTFOLIO

POKETONE Portfolio

- We supply several injection and extrusion grades with the range of MI from 3 to 200 g/10min (@240°C).
- We also produce low melting temperature grades.

Grade	Description	Process	MI	Tm
M930F	Very high flow	Injection	200	220
M330F	High flow		60	220
M710F	Process improved & High viscosity	Injection & Extrusion	6	197
M630F	Low Flow, High Impact		6	220
M410F	Process improved & High flow		40	197
M730F	Very Low Flow	Extrusion	3	220
M330F-S	High flow & White	Injection	60	220
M410F-S	Process improved & High flow & White	Injection	40	197

※ There are differentiated grades having other additives package and fillers for food contact, UV resistance, reinforced.

II. POKETONE Properties / Applications

1

POKETONE Characteristic – "High Impact Strength"

- Higher impact strength compared to existing ENPLA(Nylon, PBT)

Items	Unit	PK**	PA6	PA66	PBT	POM
Density	g/cm ³	1.24	1.14	1.14	1.30	1.41
Melting Temperature	°C	222	220	260	220	160
Impact Strength	KJ/m ²	17	5.2	4.1	5.0	6.5
Tensile Strength at Yield	MPa	60	80	80	55	65
Nominal Strain at Break	%	300	17	19	16	35
Flexural Modulus	MPa	1,550	2,600	2,900	2,400	2,500

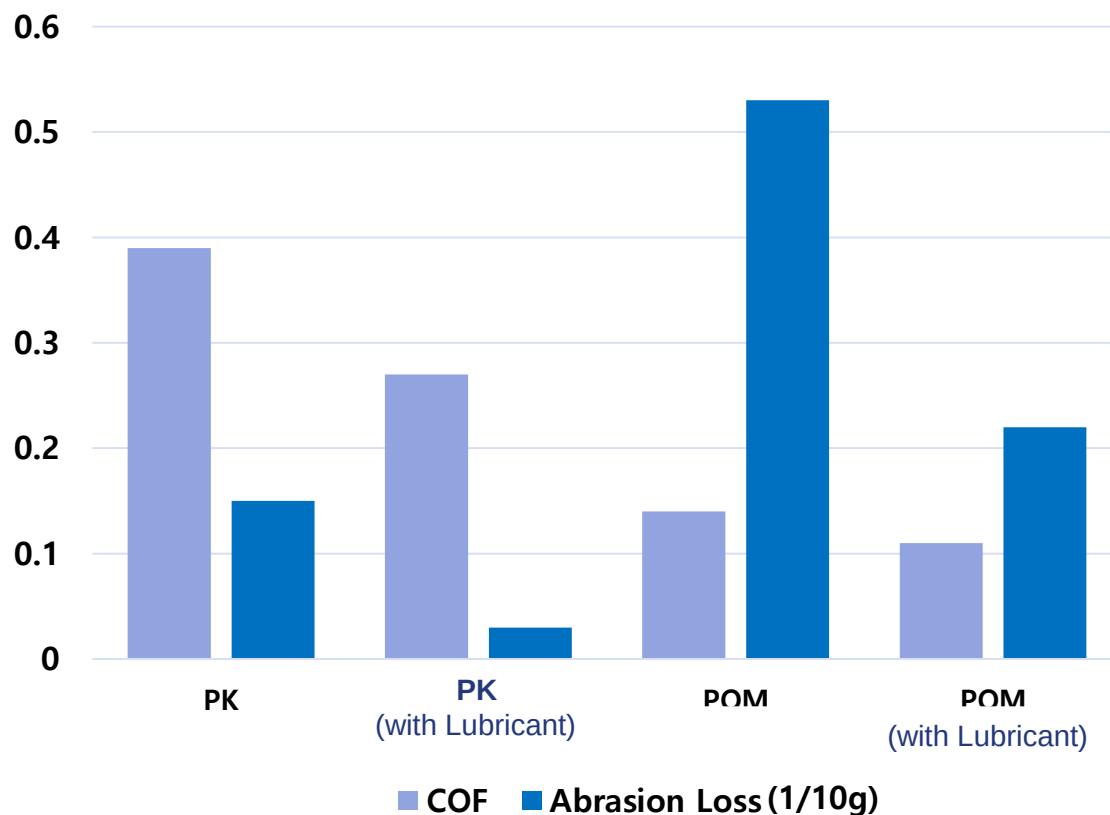
** PK (POKETONE) : M630F

II. POKETONE Properties / Applications

2

POKETONE Characteristic – "High Wear Resistance"

- POKETONE has similar or higher anti-abrasion property compared to POM
- Compared to POM, Noise is reduced distinctly



▶ Test Standard : JIS K7218

▶ Vs Same Resin

▶ Speed : 50 RPM

▶ Load : 150 N

▶ Distance : 3.0 km

■ Performance Reliability Evaluation Data

- Chemical Stress (Dimensional Change) Evaluation to Grease, Anti-Rust Additives, Releasing Agent
- ATM & Printers Assembling/Operating Evaluation (3 month)

Gear Wear Test Result							
Item		Condition			Abrasion Loss(g)		Noise
Drive Gear	Driven Gear	Speed (RPM)	Time (Day)	Interval (μm)	Drive Gear	Driven Gear	dB
POM	POM	600	7	100	0.0016	0.0086	62
PK	PK				0.0006	0.0029	56
Reinforced POM	Reinforced POM				0.0008	0.0043	59



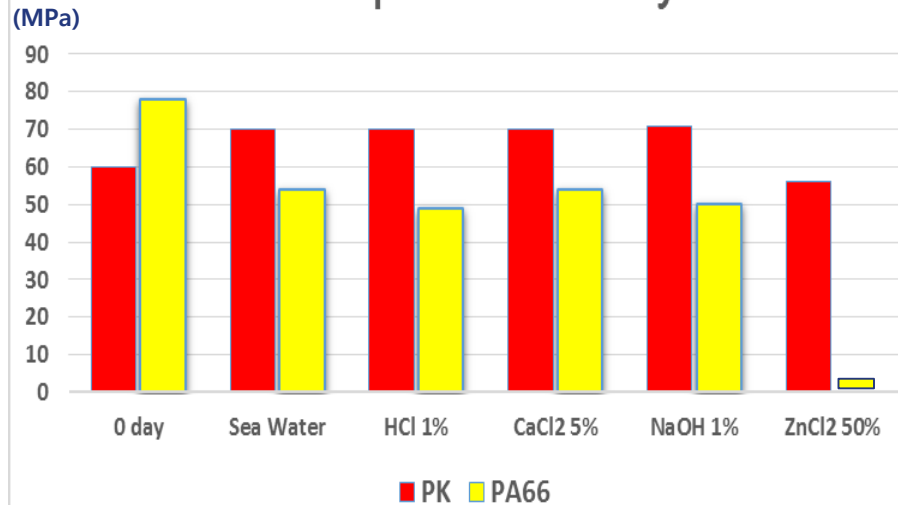
3

POKETONE Characteristic – "High Chemical Resistance"

- POKETONE has good chemical resistance to almost all chemical materials except strong acid/alkali
- Good mechanical property retention at exposure to chemical material

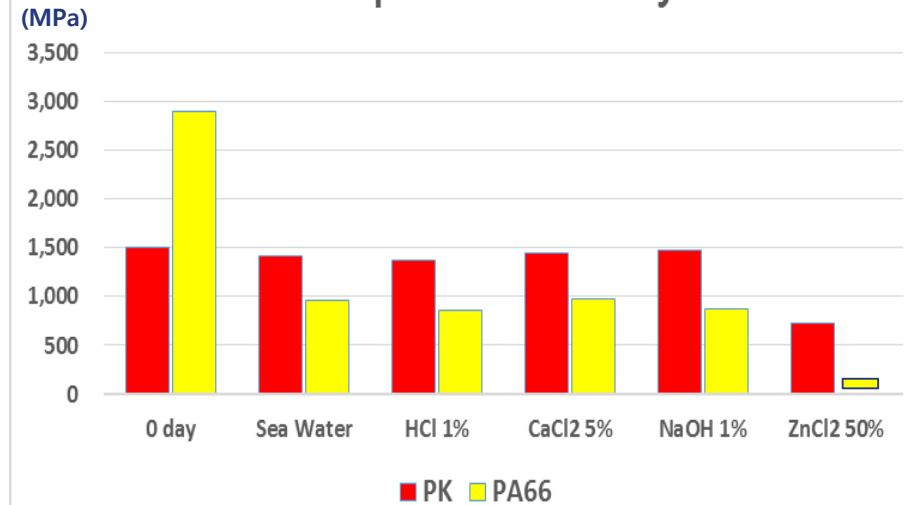
Tensile Strength

80°C Exposure for 25 Days



Flexural Modulus

80°C Exposure for 25 Days



Chemical Resistance

	Semi-Crystalline							Amorphous		
	PK	PA66	PA12	POM	PBT	PPS	PVDF	PPO	PSU	PC
Hydrocarbons										
Aliphatic	○	○	○	○	○	○	○	●	●	●
Aromatic	○	○	○	○	○	○	○	●	●	●
Halogenated	○	○		○		○	○	●	●	●
Ketones	○	○	○	○	○	○		●	●	●
Esters/Ethers	○	○	○	○	○	○	○	●	●	●
Aldehydes	○	●	●	○	○	○	○	●	●	●
Aqueous										
Water	○	●	○	○	●	○	○	○	○	○
Weak Acids	○	●	●	●	●	○	○	○	○	○
Weak Bases	○	●	●	○	●	○	●	○	●	○
Strong Acids	●	●	●	●	●	●	○	○	●	○
Strong Bases	●	●	●	○	●	●	●	●	●	●

○ : Resistant

● : Not Resistant

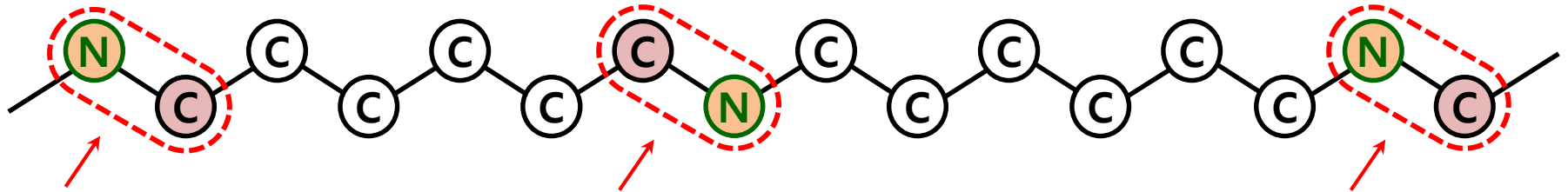
* Remark : Relative Ranking including Temperature Effects

- PA : Amide Group (-NH-CO-) is weak to Water/Acid/Alkaline
- PK : Main Chain is composed with only C-C, so stable to Water/Acid/Alkaline

Polyamide

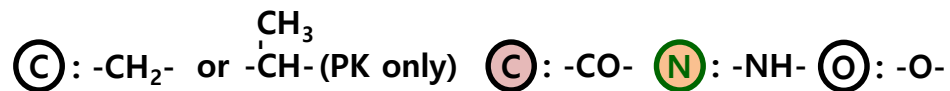
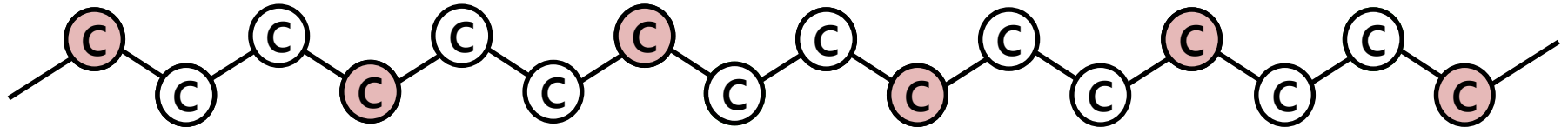
H₂O

Weak to Acid



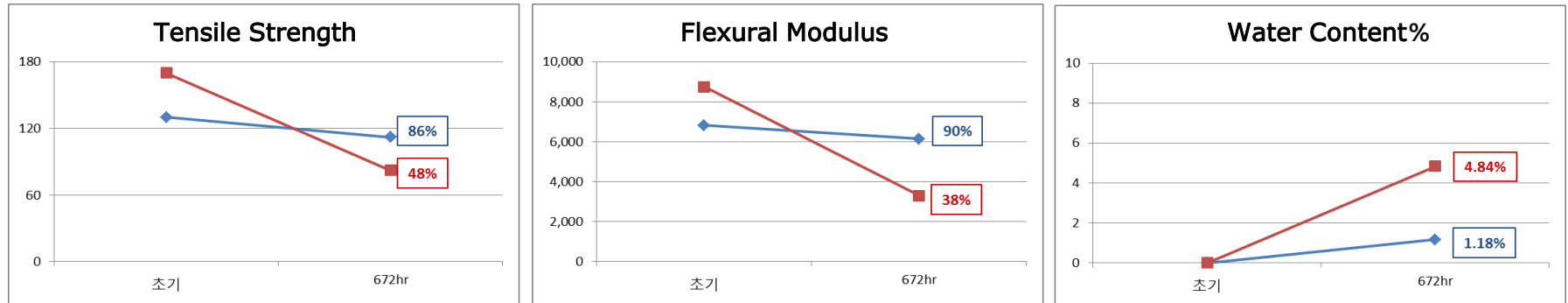
Polyketone

Stable to H₂O, Acid, Base



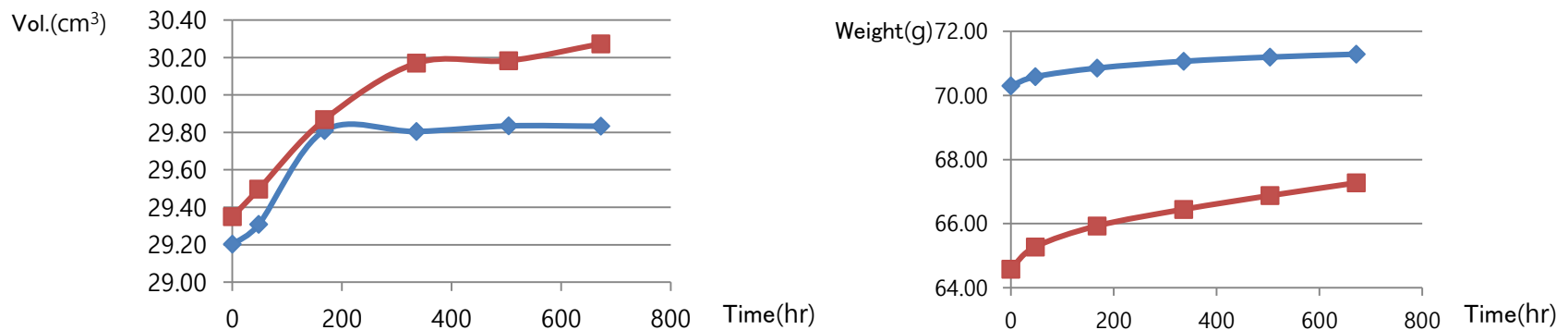
* Properties Retention Rate after immersed in Water (23°C, 672hr)

- Tensile Strength: PK 86% vs PA 48%, Flexural Modulus: PK 90% vs PA 38%



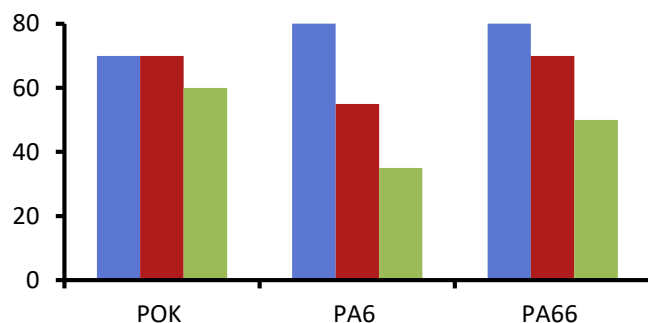
* Dimensional Change after immersed in water (23°C, 672hr)

- Volume Change : PK 2.16% vs PA 3.14%, Weight Change : PK 1.41% vs PA 4.17%

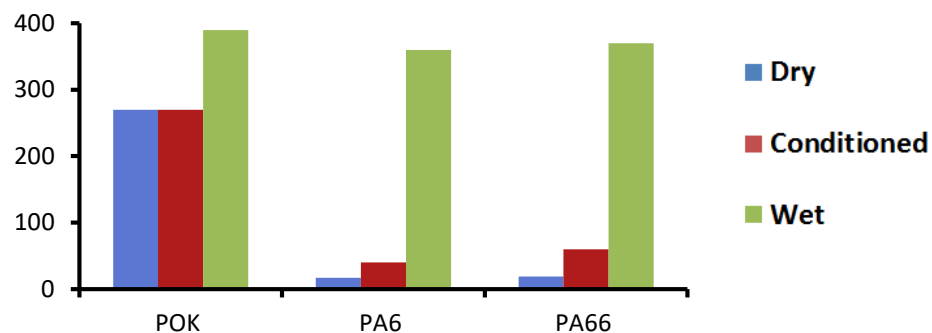


▪ Much Less sensitive to Humidity than Polyamides

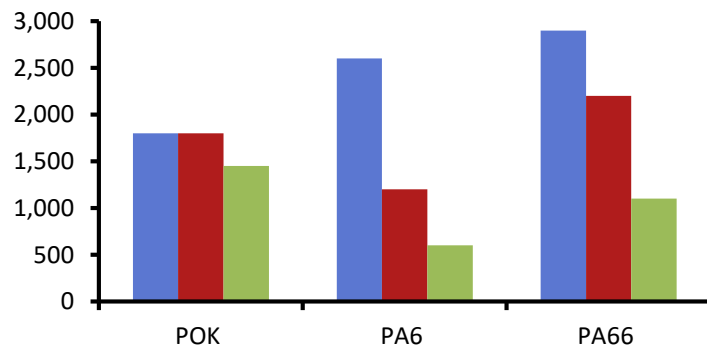
Tensile Strength (MPa)



Tensile Elongation (%)



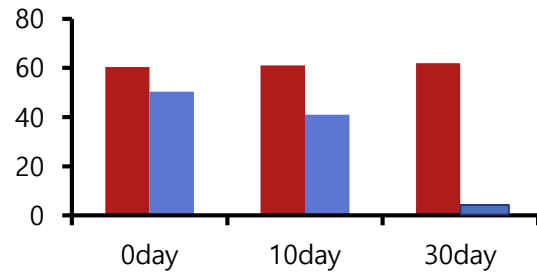
Flexural Modulus(MPa)



- Dry: 23°C, 50% RH, 24hrs
- Conditioned: 23°C, 50% RH, 60days
- Wet: 23°C, 90% RH, 60days

- **Superior Hydrolytic Stability compared to PBT,**

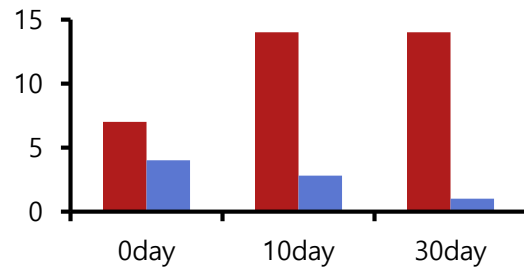
Tensile Strength (MPa)



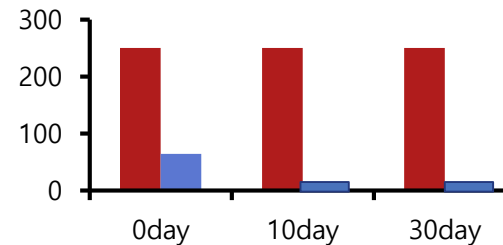
Test condition: 100°C Water for 30days

■ POK
■ PBT

Impact Strength (KJ/m²)



Elongation (%)



- Superior GWEPT at 750°C than PA6 : POKETONE: No ignition, PA66: Ignition

Properties	Unit	POKETONE M332AF2JY	POKETONE M332AG2JY	PA66
		V0, no GF	V0, GF 10%	V0, no GF
Water Absorption	%	0.45	0.4	1.3
Tensile Strength	MPa	50	57	80
Elongation at Break	%	40	13	18
Flexural Modulus	MPa	1,800	3,200	3,400
Flammability	-	V0	V0	V0
Comparative Tracking Index	PLC	0	0	0
Dielectric Strength	kV/mm	26.53	29.23	22
GWEPT* @ 750°C	-	No ignition	No ignition	Ignition

III. POKETONE Certifications

Green Certification

▪ New Green Polymeric Material

- In Aug, of 2016, Got 「Green Certification」from Ministry of Trade, Industry and Energy
- Technologies for manufacturing new green polymer(Polyketone) utilizing carbon monoxide and olefins

▪ 「Green Certification」

- Based on「Basic Act on Low Carbon Green Growth」, Supporting/Certifying system Green Technologies

Polyketone 50,000MT

Carbon Monoxide Consumption 25,000MT

(CO emitted from vehicles, chemical plants and others would be changed to CO₂ easily, reacting with Oxygen in the atmosphere)

**Total Emission of Air pollution source in Korea :
3.68 mil. MT**

▪ NO _x	28.8%	<i>Nitrogen Oxide</i>
▪ VOC	23.5%	<i>Volatile Organic Compounds</i>
▪ CO	20.9%	<i>Carbon Monoxide</i>
▪ SO _x	10.9%	<i>Sulfur Oxide</i>
▪ NH ₃	7.9%	<i>Ammonia Emission</i>
▪ TSP	4.8%	<i>Total Suspended Particulate</i>
▪ PM ₁₀	3.2%	<i>Particle Matter in Diameter 10μm</i>

Same as 3.80 mil. Pine Tree

(30yr. Pine tree purify 6.6 Kg/yr CO₂)

Source : National Institute of Environmental Research (Korea)



* Major 6 Air Pollution Source : CO, NO_x, SO_x, NH₃, VOC, PM

III. POKETONE Certifications

Green Certification

Certificate of Green Technology

Certificate No : GT-16-00103

Company : HYOSUNG Corporation

President : LEE, Sang Woon

Address : 119, Mapo-daero, Mapo-gu, Seoul, Korea

Technology : Technologies for manufacturing new green polymer (polyketone) utilizing carbon monoxide and olefins

Classification No : T071201

We hereby certify that the above-mentioned Technology has been approved as a Green Technology by the Ministry of Trade, Industry and Energy of the Korean Government under Article 32 of the Framework Act on Low Carbon, Green Growth and Article 27 of the Management Code on Green Certification System.

Date of Issue : 2016.08.11

Date of Expiration : 2019.08.10

**Ministry of Trade,
Industry and Energy**



Confirmation of Green Technology Product

Certificate No : GTP-16-00185

Product Name : Polyketone

(Model Name) POKETONE M(a)(b)(c)(d)

Certified Technology : Technologies for manufacturing new green polymer (polyketone) utilizing carbon monoxide and olefins

Classification No : GT-16-00103

Company : HYOSUNG Corporation

President : LEE, Sang Woon

Address : 119, Mapo-daero, Mapo-gu, Seoul, Korea

We hereby confirm that the above-mentioned Product has been approved as a Green Technology Product by the Ministry of Trade, Industry and Energy of the Korean Government under Article 32 of the Framework Act on Low Carbon, Green Growth and Article 27 of the Management Code on Green Certification System.

Date of Issue : 2016.8.11

Date of Expiration : 2019.08.10

**Ministry of Trade,
Industry and Energy**



III. POKETONE Certifications

NSF/ANSI 51 - F Grade

NSF International

789 N. Dixboro Road, Ann Arbor, MI 48105 USA

RECOGNIZES

Hyosung Corporation

Facility: Ulsan, Republic of Korea

AS COMPLYING WITH NSF/ANSI 51 AND ALL APPLICABLE REQUIREMENTS.

PRODUCTS APPEARING IN THE NSF OFFICIAL LISTING ARE

AUTHORIZED TO BEAR THE NSF MARK.



This certificate is the property of NSF International and must be returned upon request. This certificate remains valid as long as this client has products in Listing for the referenced standards. For the most current and complete Listing information, please access NSF's website (www.nsf.org).

April 15, 2016
Certificate# C0219121 - 01



Sarah Krol
Global Managing Director, Food Safety Product Certification

III. POKETONE Certifications

NSF/ANSI 61 - Water Contact Certificate

NSF International

789 N. Dixboro Road, Ann Arbor, MI 48105 USA

RECOGNIZES

Hyosung Corporation
Facility: Ulsan, Republic of Korea

AS COMPLYING WITH NSF/ANSI 61 AND ALL APPLICABLE REQUIREMENTS.
PRODUCTS APPEARING IN THE NSF OFFICIAL LISTING ARE
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This certificate is the property of NSF International and must be returned upon request. For the most current and complete information, please access NSF's website (www.nsf.org).

February 6, 2015
Certificate# C0219119 - 01

A handwritten signature in black ink, appearing to read "David Purkiss".

David Purkiss
General Manager, Water Systems

III. POKETONE Certifications

FDA FCN No.1847



May 11, 2018

George Misko
Keller and Heckman LLP
1001 G Street N.W.
Suite 500 West
Washington D.C. 20001
misko@khlaw.com

RE: Food Contact Substance Notification (FCN) 001847

Final Letter
Replaces FCN 001562

Dear Mr. Misko:

This letter is in reference to the notification for the food contact substance and use described as follows:

Food Contact Substance (FCS)

Carbon monoxide-ethylene-propylene terpolymer (CAS Reg. No. 88995-51-1)

Notifier

Hyosung Corporation

Manufacturer/Supplier

Hyosung Corporation

Intended Use

For use as a component of: a) multilayer flexible packaging; b) reheatable or microwavable rigid retort packaging; and c) repeated use food-contact articles; except for use in contact with infant formula and human milk (see Limitations/Specifications).

III. POKETONE Certifications

EU Directives 2011/10

Regulatory Consulting



CERTIFICATE

of compliance with the
European Commission Regulation (EU) No 10/2011 and its amendments
for

Hyosung Polyketone:
M230F, M330F, M630F, M730F, M620F

The detailed compositions of the above mentioned materials have been disclosed by Hyosung Corporation, 235, Banpo-Daero, Seocho-Gu, Seoul, 137-804, Korea to Envigo, Regulatory Consulting, Itingen / Switzerland on October 26th, 2015. Based on the evaluation of this information for compositional compliances we herewith can confirm that the above mentioned plastic materials are in compliance with the European Commission Regulation (EU) No 10/2011 on plastic materials and articles intended to come into contact with food, including its last amendment Commission Regulation (EU) No 174/2015.

Limitations:

The final articles coming into contact with foodstuffs must comply with the general provisions for food contact materials and must not endanger human health or bring about an unacceptable change in the composition of the food or bring about a deterioration in the organoleptic characteristics thereof.

It must also comply with the overall migration limit of 10 mg/dm² contact surface or 60 mg/kg food and with the specific migration limit of 6 mg/kg food for Methacrylic Acid (CAS No 79-41-4).

The specific migration of the dual use additive Calcium Phosphate (CAS No 7758-87-4, E 341) from the final article coming into contact with foodstuffs has to be considered with respect to the limits set in the food legislation.

This certificate is based on the information provided to Envigo, Regulatory Consulting and on the present legislation as mentioned above. The validity expires in case of any relevant modification of the formulation or any change of the legislation.



Dr. W. Nef
Expert Consultant,
Food Contact Materials



Dr. S. Niven
Business Lead Consultant,
Chemicals

Itingen, November 17th, 2015
Expiration date: November 16th, 2018
Envigo Project E00906a / NEW

Envigo, Regulatory Consulting, • Zeltweg 1 • 4452 Itingen Switzerland • Phone +41 61 975 11 11 • Fax +41 61 975 5264 • www.envigo.com

1/1

Regulatory Consulting



CERTIFICATE

of compliance with the
European Commission Regulation (EU) No 10/2011 and its amendments
for

Hyosung Polyketone:
M230A, M330A, M630A, M730A, M620A

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Dr. W. Nef
Expert Consultant,
Food Contact Materials



Dr. S. Niven
Business Lead Consultant,
Chemicals

Itingen, November 17th, 2015
Expiration date: November 16th, 2018
Envigo Project E00906b / NEW

Envigo, Regulatory Consulting, • Zeltweg 1 • 4452 Itingen Switzerland • Phone +41 61 975 11 11 • Fax +41 61 975 5264 • www.envigo.com

1/1

III. POKETONE Certifications

ACS Certificate – Water Contact Certificate

 **Expertises Environnementales**

Laboratoire habilité par le Ministère chargé de la santé en application de l'article R*, 1321-52 du code de la santé publique

ATTESTATION DE CONFORMITE SANITAIRE (ACS)

Certificate of sanitary conformity

Conformément à l'arrêté du 29 mai 1997 modifié et aux circulaires du Ministère de la Santé DGS/VS4 n° 99/217 du 12 avril 1999 et DGS/VS4 n° 2000/232 du 27 avril 2000

Coordonnées du demandeur / Contact details of the ACS owner : HYOSUNG Group 119, Mapo-daero, Mapo-gu 04144 SEOUL KOREA	Nom(s) commercial(aux) du produit fini / Commercial name(s) of the finished product : POKETONE F Grade
---	--

Type de produit fini / Type of finished product :

☒ tube / pipe	☐ joint / seal, gasket, o-ring...	☐ revêtement / coating
☐ produit de jointoyage / sealing product	☐ raccord et manchon / fittings	☐ composant d'accessoires / accessories components
☐ autre / other :		

Nature du matériau / Type of material :

☐ polychlorure de vinyl PVC	☐ polybutylène PB	☐ éthylène-propylène EPDM
☐ PVC surchloré PVC-C	☐ polyamide PA	☐ butadiène-acrylonitrile NBR
☐ polyéthylène PE	☐ polytétrafluoroéthylène PTFE	☒ autre / other : Polycétone / Polyketone
☐ polyéthylène réticulé PEX	☐ acrylonitrile-butadiène-styrène ABS	
☐ polypropylène PP	☐ à base de résine époxydique / epoxy resin	

Commentaires / Comments :
Couleur du matériau / Material color : Blanc / White

N° de dossier attribué par le laboratoire habilité / File reference : 17 MAT NY 031

Formulation chimique / Chemical formulation :
Vérifiée par le laboratoire et conforme aux listes positives /
Checked by the laboratory and conform to the positive lists

Essais d'inertie réalisés selon la norme XP P 41-250 / Migration tests performed according to the standard XP P 41-250 :
Rapport S/V testé / S/V tested ratio : 240 cm²/L
Date des essais / Tests date : du 20 février au 30 mars 2017 / from February 20 to March 30, 2017.
Commentaires : Les essais d'inertie réalisés selon les normes AFNOR XP P 41-250-1/2/3 et NFP 41-290 n'ont fait apparaître aucune anomalie. Les résultats sont conformes aux exigences de la circulaire DGS/VS4 n°99-217 du 12 avril 1999.
Comments : The migration test carried out according to the standards XP P 41-250-1/2/3 and NFP 41-290 do not bring out any anomaly. The results are in accordance with the requirements of the circular DGS/VS4 n°99-217 of the 12th of April 1999.

Attestation délivrée par / Certificate issued by :

Clémence Tafforeau Chef de Service / Material Department Manager	Signature : 
---	---

A la date du / Date of issue : 30 mars 2017
Date d'expiration de l'ACS / Expiry date : 30 mars 2022
Commentaires / Comments : /

Eurofins Expertises Environnementales
SAS au capital de 71676 € RCS Nancy 751 056 102 TVA FR 35 751 056 102
Siège social : Rue Lucien Cuénot site Saint Jacques II BP 51005 54521 MAXEVILLE cedex – T 03 83 50 36 17 F 03 83 50 23 70

référence : T-AM-FO26359 Version : 14.1 Date de publication : 07.10.2015

III. POKETONE Certifications

WRAS Certificate - Water Contact Certificate

Approval Number: 1708523
Test Report: MA6003/Z 1&2



Water Regulations Advisory Scheme Ltd.
Unit 13,
Willow Road,
Pen y Fan Industrial Estate,
Crumlin,
Gwent,
NP11 4EG

21st August 2017

Hyosung Corporation
Banpo Hyosung Building 18 Floor POK Biz,
235, Banpo-daero,
Seochu-gu,
Seoul 06575,
Republic of Korea

WATER REGULATIONS ADVISORY SCHEME LTD. (WRAS) **MATERIAL APPROVAL**

The material referred to in this letter is suitable for contact with wholesome water for domestic purposes having met the requirements of BS6920-1:2000 and/or 2014 'Suitability of non-metallic products for use in contact with water intended for human consumption with regard to their effect on the quality of the water'.

The reference relates solely to its effect on the quality of the water with which it may come into contact and does not signify the approval of its mechanical or physical properties for any use.

THERMOPLASTIC MouldING COMPOUND

5585

'M930F, M330F, M630F, M620F, M730F & M710F'. Beige coloured, injection moulded polyketone materials. For use with water up to 85°C.

APPROVAL NUMBER: 1708523
APPROVAL HOLDER: HYOSUNG CORPORATION

The Scheme reserves the right to review approval.
Approval 1708523 is valid between August 2017 and August 2022

An entry, as above, will accordingly be included in the Water Fittings Directory on-line under the section headed, 'Materials which have passed full tests of effect on water quality'.

The Directory may be found at: www.wras.co.uk/directory

Yours faithfully



Jason Furnival
Approvals & Enquiries Manager
Water Regulations Advisory Scheme

WRAS MATERIAL APPROVAL - MATERIALS WHICH HAVE PASSED FULL TESTS OF EFFECT ON WATER QUALITY

The material referred to in this letter is suitable for contact with water for domestic purposes. **Approval of this material does not signify the approval of its mechanical or physical properties for any use.**

Manufacturers or applicants may only quote in their sales literature terms which are used in this letter, namely that; 'the material as listed, having passed the tests of effect on water quality, is suitable for use in contact with wholesome water'

This may be abbreviated to 'Water Regulations Advisory Scheme - Approved Material' or 'WRAS Approved Material'.

The scope of an Approval does not extend to rebranded materials unless otherwise agreed by the Scheme.

Use of the WRAS Approved Material Logo

Approval holders may use the WRAS Approved Material logo and make reference to any approval issued by WRAS Ltd. in respect of a particular material or range of materials provided the approval is, and remains valid.

Approval holders are entitled to use the logo on the packing, promotional literature and point of sale advertising Approved Materials.

Modifications to existing Approvals

It is a condition of WRAS Material Approval that NO changes or modifications to the Approved Material, be made without the Approval Holder first notifying WRAS Ltd. Full details of the proposed changes must be provided to the Scheme. Failure to comply with this condition will immediately invalidate a previously granted Approval.

Re-Approval

WRAS will write to you 1 year before the approval expires asking whether you would like to renew it. Please complete the relevant section of the MA3 application form which will be included with the letter and return to WRAS (via e-mail or post).

Please note it is the responsibility of the Approval Holder to ensure the Approval remains valid. WRAS Ltd. accepts no liability for the delay in granting approval where this is caused by circumstances outside of the Scheme's control.

III. POKETONE Certifications

KTW Certificate - Water Contact Certificate

Hygiene-Institut des Ruhrgebiets

Institut für Umwelthygiene und Toxikologie

Direktor: Prof. Dr. rer. nat. L. Dunemann

Träger: Verein zur Bekämpfung der Volkskrankheiten im Ruhrkohlengebiet e.V.



Hygiene-Institut des Ruhrgebiets

Institut für Umwelthygiene und Toxikologie

back side of test certificate

K-291309-17-Bs/st

The mentioned product meets the requirements according to the test report-no.: **K-291309-17-Bs/st dated 08.11.2017** for the following product group(s) and temperature(s), as far as technically suited.

HYGIENE-INSTITUT · Postfach 10 12 55 · 45812 Gelsenkirchen / GERMANY

Hyosung Corporation
119, Mapo-daero, Mapo-gu
04144 SEOUL
REPUBLIC OF KOREA

Visitor's/Parcel Address:
Rothhauser Str. 21
45879 Gelsenkirchen

Telephone +49 (0) 209 9242-0
Extension +49 (0) 209 9242-351
Telefax +49 (0) 209 9242-212
E-Mail a.bernoussi@hyg.de
Internet www.hyg.de

Reference No.: **K-291309-17-Bs/st**
Contact person: Anasse Bernoussi (Eng.)

Gelsenkirchen, 08.11.2017

TEST CERTIFICATE according to the KTW Guideline

Product: POKETONE grade M330F 40EA

Test Specimen: plates 125 mm x 125 mm x 3 mm (light yellow)

The above mentioned product was tested according to the Guideline on the hygienic assessment of organic materials in contact with drinking water of the German Environment Agency. Pursuant to the test report-no.: **K-291309-17-Bs/st dated 08.11.2017** the product meets the requirements for the product group:

**Containers in the drinking water installation including repair systems
in contact with cold water (23°C), warm water (60°C) and hot water (85°C).**

All product groups for which the requirements are met are summarised on the back side.

The certificate is valid providing that the requirements, laid down in the Guideline regarding the testing of the microbial growth are fulfilled. This can be verified for the product f.e. with a valid test certificate according to the DVGW technical rule W 270.

This test certificate is valid beginning with the date of issue and is ending by **08.11.2022** as far as there are no changes in the formula. The test certificate may be extended for further five years, provided that the formulation, the relevant evaluation criteria (restrictions in the positive lists), the production process and the production place of the product have not changed.

The Director of the Hygiene-Institute
on behalf of

Dr. rer. nat. Andreas Koch
Head of the Dept. for water
hygienic material testing



Product group	cold water (23°C)	warm water (60°C)	hot water (85°C)
Pipes with DN < 80 mm (service and domestic pipes)			
Pipes with 80 mm ≤ DN < 300 mm (distribution pipes)			
Pipes with DN ≥ 300 mm (large distribution, mains)			
Fittings for pipes with DN < 80 mm	passed	passed	passed
Fittings for pipes with 80 mm ≤ DN < 300 mm	passed	passed	passed
Fittings for pipes with DN ≥ 300 mm	passed	passed	passed
Seals for pipes with DN < 80 mm	passed	passed	passed
Seals for pipes with 80 mm ≤ DN < 300 mm	passed	passed	passed
Seals for pipes with DN ≥ 300 mm	passed	passed	passed
Containers in the drinking water installation including repair systems	passed	passed	passed
Containers outside the drinking water installation including repair systems	passed	passed	passed
Repair systems for containers in the drinking water installation with 1/100 of the surface area of the container	passed	passed	passed
Repair systems for containers outside the drinking water installation with 1/100 of the surface area of the container	passed	passed	passed
Small contact area components of materials for pipes with DN < 80 mm that are only installed in one place in the distribution system (e.g. plain bearing of a pump)	passed	passed	passed
Small contact area components of materials for pipes with 80 mm ≤ DN < 300 mm, that are only installed in one place in the distribution system (e.g. plain bearing of a pump)	passed	passed	passed
Small contact area components of materials for pipes with DN ≥ 300 mm, that are only installed in one place in the distribution system (e.g. plain bearing of a pump)	passed	passed	passed

If further products or components with the same formulation are produced with the same process at one production site and differ only in geometry, this test certificate applies to further parts of this product range.

The assessment was based on the assumption that the used starting substances and monomers used to manufacture the product may completely known and no other substances are present in the product. The validity of this document expires in case of modifications in the composition of the product or the processing conditions. The results and evaluations refer to the groups of test items. This document may not be published without our written permission only complete and unchanged or duplicated.

Träger: Verein zur Bekämpfung der Volkskrankheiten im Ruhrkohlengebiet e.V., Vereinsregister: VR 519 Amtsgericht Gelsenkirchen, USt-ID: DE125018356
Vorstand: Prof. Dr. Werner Schlake (Vors.), Prof. Dr. Jürgen Kretschmann, Dr. Emanuel Grün, Dr. Dirk Waider, Prof. Dr. Lothar Dunemann (geschäftsf. Vorstand)

Commercialized Applications

※ 12 Classifications with POKETONE values in use

Classification	Uses	POKETONE Values
Connector	Automotive Connector (Interior)	High flow, Impact strength, Hinge
	E&E Connector	High flow, Impact strength, Hinge, GWIT
Water contact	Pump(Body, Impeller, Diffuser, etc)	Hydrolytic stability, Pressure resistance,
	Water purifier(Tank, Fitting, Valve, Cock, etc)	Chemical resistance, Impact strength,
	Faucet(Shower Head, Angle Valve, Catridge, etc)	Low water absorption, Harmlessness
	Plumbing(T, Elbow, Hot Water Distribution, etc)	
	Boiler Heat Exchanger	
	Sludge Chain at Waste Water Treatment	
Water meter	Water Meter Body	Hydrolytic stability, Pressure resistance,
	Water Meter Inside Parts	Chemical resistance, Impact strength, Low water absorption, Harmlessness
Cosmetic container	Cushion Plate	Chemical resistance, Harmlessness
	Rotation Plate, Lip-stick Rotation Part	
	Mascara Stick, Eyebrow	
	Container, Cap, etc	

Commercialized Applications

※ 12 Classifications with POKETONE values in use

Classification	Uses	POKETONE Values
Gear	Printer Gear	Abrasion resistance, Low noise
	Toy Gear	
	Gear of Health Machine	
	ATM Gear	
	Robot Cleaner Gear	
	Bearing Dish Washer	
Wheel	Elevator Wheel	Abrasion resistance, Low noise, Impact strength
	Caster	
	Furniture Wheel, Cart Wheel	
Oil&Gas	Oil&Gas Drilling Pipe Liner	Barrier property(Oil&Gas), High HDT, Chemical resistance, Abrasion resistance
Railway Fastening System	Dowel	Low water absorption, Impact strength
	Plate	
Conveyor Belt	Food contact	Chemical resistance, Impact strength, Abrasion resistance, Harmlessness
Automotive	Overhead Console Latch	Abrasion resistance
	Head Lamp Washing System	Pressure resistance, Chemical resistance

Commercialized Applications

※ 12 Classifications with POKETONE values in use

Classification	Uses	POKETONE Values
Food contact	Slush Mixer Cover	
	Ice Auger	
	Coffee Machine Parts(Seal, etc)	
Agricultural part	Sprinkler	Pressure resistance, Chemical resistance
Others	Yarn Guide	Abrasion resistance
	Helmet Shield Ratchet	Abrasion resistance, Low noise
	Hydraulic Seals(Oring)	Chemical resistance, Compression strength

Other ENPLA Issues

Polymer	Current Issues	POKETONE Values
m-PPO/m-PPE	- Shortage of SABIC - Odor, Taste trouble - High processing temp	▶ Low Odor, Taste ▶ Energy saving ▶ Resilience (Pressure Cycle Test)
PPS/PSU/PPSU	- High Price ENPLA - Bad processing ability	▶ Cost performance ▶ Excellent processing ability
PA66	- Water absorption (Mechanical properties drop & Dimension change) - Low toughness - Bad chemical resistance	▶ Low water absorption ▶ High toughness ▶ Good chemical resistance
PBT	- Hydrolysis - Low impact strength - Bad chemical resistance - Bad flowability	▶ Hydrolytic stability ▶ Good impact strength ▶ Good chemical resistance ▶ Excellent flowability
POM	- Formaldehyde emmission - Low impact strength - Bad chemical resistance	▶ Formaldehyde free ▶ Good impact strength ▶ Good chemical resistance
[Other Merits]		▶ Exellent barrier properties (Fuel, Gas, etc) ▶ Abrasion resistance

Commercial Plant 50,000MT line





Thank You!

『POKETONE』

- Application package -

Hyosung Chemical Corporation
POK Business Unit

POKETONE Certifications



■ Eco-friendly material



POKETONE™ is eco-friendly and non-toxic characteristics, such as no VOCs (Volatile Organic compounds), free of formaldehyde, heavy metal and acrylonitrile, making it perfect for baby toys, food contact and MEDICAL applications. All F grades of POKETONE are satisfied with FDA, NSF 51,61, and USP Class VI.

Drinking Water contact certification

	KTW (Germany)	DVGW, W270 (Germany)	NSF/ANSI 61 (US)	ACS (France)	WRAS (UK)
PA6, 66	  		  		  
POM	  		  		  
PA12	  	Certified	  	Certified	  
PSU/PPSU	  	Certified	  	Certified	  
POKETONE	  	Certified	  	Certified	  

 Hot
  Warm
  Cold

POKETONE provides all major HOT Water certificates with price competitiveness

Products	Grade	NSF61	WRAS	ACS	KTW	DVGW, W270
POKETONE™ F Series	M230F	  	V	OK	  	OK
	M930F	  	  	OK	  	OK
	M330F	  	  	OK	  	OK
	M630F	  	  	OK	  	OK
	M620F	  	  	OK	V	OK
	M730F	  	  	OK	  	OK
	M710F	V	  	OK	V	OK
POKETONE™ A Series	M230A	  	V	V	V	V
	M330A	  	V	V	V	V
	M630A	  	V	V	V	V

 HOT,
  Warm,
  Cold,
 DI(Under Process), OK(Completion),

V(No Certificate But No problem to get the certificate)

Toys (& Sporting Goods)

PK VALUE IN USE

PK PROPERTIES



Properties	Unit	POKETONE M330	POKETONE M630
Density	-	1.24	1.24
Melt Index	g/10min	60	6
Tensile Strength	MPa	60	58
Elongation at Break	%	> 240	> 240
Flexural Strength	MPa	57	53
Flexural Modulus	MPa	1,500	1,350
Impact Strength	KJ/m ²	8	17

- REFERENCE

McDonalds RSS Pass : M330F, M630F (Distributor : Polymer Solution_Hongkong)

Ferrero Rocher Green List Pass : M330F-S (Distributor : Chi Bond_Hongkong)

HASBRO SRS Pass : POKETONE Base Grade

- POKETONE SAFETY TEST

Auftraggeber: Client:	FERRERO TRADING LUX S.A. FINDEL BUSINESS CENTER COMPLEXE B, RUE DE TRÈVES, L-2632 FINDEL, Luxembourg
Prüfgegenstand: Test item:	Toy for children
Bezeichnung / Typ-Nr.: Identification / Type No.:	FERRERO "Green List" - Resin "POK M330F-S" Supplier: Hyosung Corporation
Wareneingangdatum: Date of receipt:	30.07.2019
Prüfmuster-Nr.: Test sample No.:	A000238316
Prüfzeitraum: Testing period:	30.07.2019 – 14.08.2019
Ort der Prüfung: Place of testing:	Toy testing Nuremberg
Prüflaboratorium: Testing laboratory:	TÜV Rheinland LGA Products GmbH
Prüfergebnis: Test result:	Pass



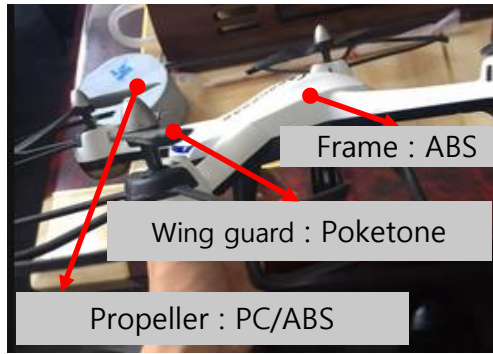
SAMPLE DESCRIPTION: One (1) group of submitted sample said to be Hyosung Corporation Polyketone M630A
 Sample received date: December 1, 2017
 Date of testing started: December 1, 2017
 Date of testing ended: December 7, 2017

TEST CONDUCTED:
 AS REQUESTED BY THE APPLICANT, FOR DETAILS REFER TO ATTACHED PAGE(S)

Tested Samples	Standard	Result
Submitted sample	McDonald's Restricted Substances Standard Revision 9 - Heavy Metal Test	For your information
	McDonald's Restricted Substances Standard Revision 9 for Monomers Requirement - Total Bisphenol - A Content	Pass



Drone for Toy



• Summary

- Current Material : PA6/66 etc.
- Product : M330, M630
- Current State : Completed, Applied

• Voice Of Customer

- Low water absorption and dimensional stability
- Impact Strength and Toughness

• Value In Use

- Eco friendly/VOCs Free
- Dimensional Stability
- Wear Resistance
- Hydrolysis Resistance
- Impact Strength

Toy for M company & F company



• Summary

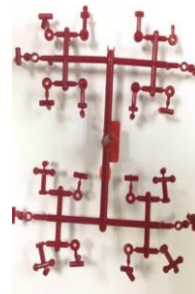
- Current Material : PA6/66, POM, etc.
- Product : M330, M630
- Current State : Completed, Applied

• Voice Of Customer

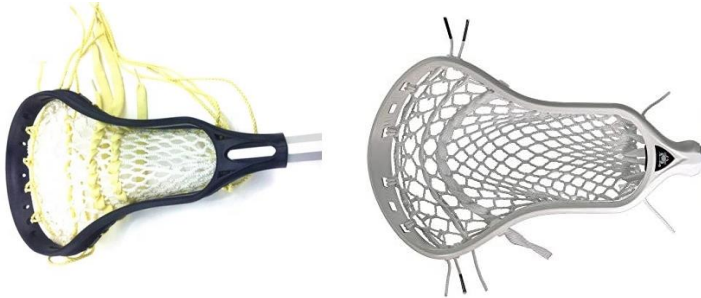
- Eco friendly/VOCs Free
- Impact Strength and Toughness

• Value In Use

- Eco friendly/VOCs Free
- Dimensional Stability
- Wear Resistance
- Hydrolysis Resistance
- Impact Strength



Lacross Racket



- Summary
 - Current Material : New developed product
 - Product : M630+UV Reinforcement
 - Current State : Completed, Applied
- Voice Of Customer
 - Eco friendly/VOCs Free
 - Impact Strength and Toughness
 - UV Resistance
- Value In Use
 - Eco friendly/VOCs Free
 - Dimensional Stability, UV Stability
 - Wear Resistance, Impact Strength

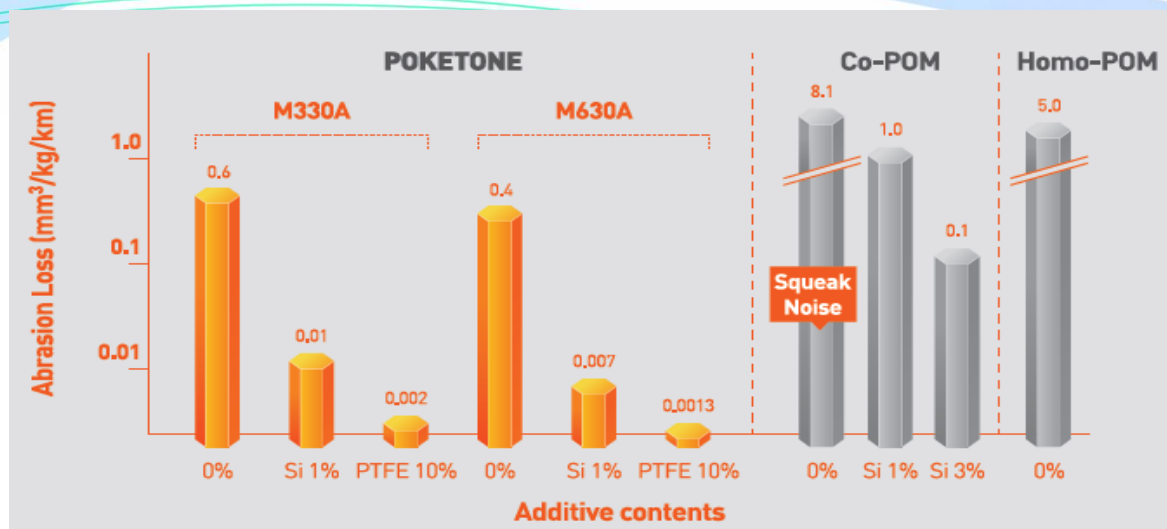
Sports Helmet (Cycling, Ski, etc)



- Summary
 - Current Material : PC (Sheet), Impact PA66
 - Product : M330, M930
 - Current State : Completed, Applied
- Voice Of Customer
 - Eco friendly/VOCs Free
 - High wear resistance
 - Easily production (reduce cost)
- Value In Use
 - Eco friendly/VOCs Free
 - Wear Resistance
 - High flowability (Easy production)

Food Contact

Abrasion / Wear Resistance



14 times higher wear properties than POM, reducing noise issues is variable wear applications

Chemical Resistance

	Semi-Crystalline							Amorphous		
	PK	PA66	PA12	POM	PBT	PPS	PVDF	PPO	PSU	PC
Hydrocarbons										
Aliphatic	○	○	○	○	○	○	○	●	●	●
Aromatic	○	○	○	○	○	○	○	●	●	●
Halogenated	○	○		○		○	○	●	●	●
Ketones	○	○	○	○	○	○		●	●	●
Esters/Ethers	○	○	○	○	○	○	○	●	●	●
Aldehydes	○	●	●	○	○	○	○	●	●	●
Aqueous										
Water	○	●	○	○	●	○	○	○	○	○
Weak Acids	○	●	●	●	●	○	○	○	○	○
Weak Bases	○	●	●	○	●	○	●	○	●	○
Strong Acids	●	●	●	●	●	●	○	○	●	○
Strong Bases	●	●	●	○	●	●	●	●	●	●

○ : Resistant ● : Not Resistant

High resistance to most chemicals, except for acid and base chemicals

Food Conveyor Belt



**High-Performance
Engineering Plastics
For the Food conveyor belt**

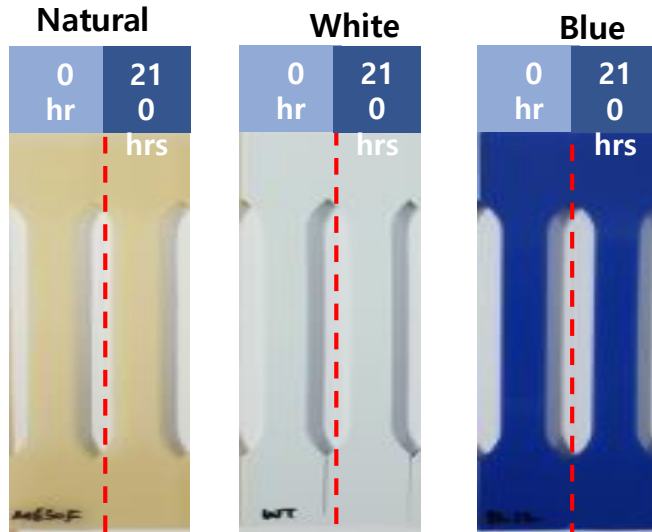
POKETONE (Aliphatic Polyketone)

✓ Properties

Properties	Unit	POKETONE M330F	POKETONE M630F	POKETONE M730F
Density	-	1.24	1.24	1.24
Melt Index	g/10min	60	6	3
Tensile Strength	MPa	60	58	58
Elongation at Break	%	> 240	> 240	> 240
Flexural Strength	MPa	57	53	48
Flexural Modulus	MPa	1,400	1,250	1,200
Impact Strength	KJ/m ²	8	17	19
Toughness	-	Best	Excellent	Excellent

Chemical resistance test for Food Conveyor belt parts

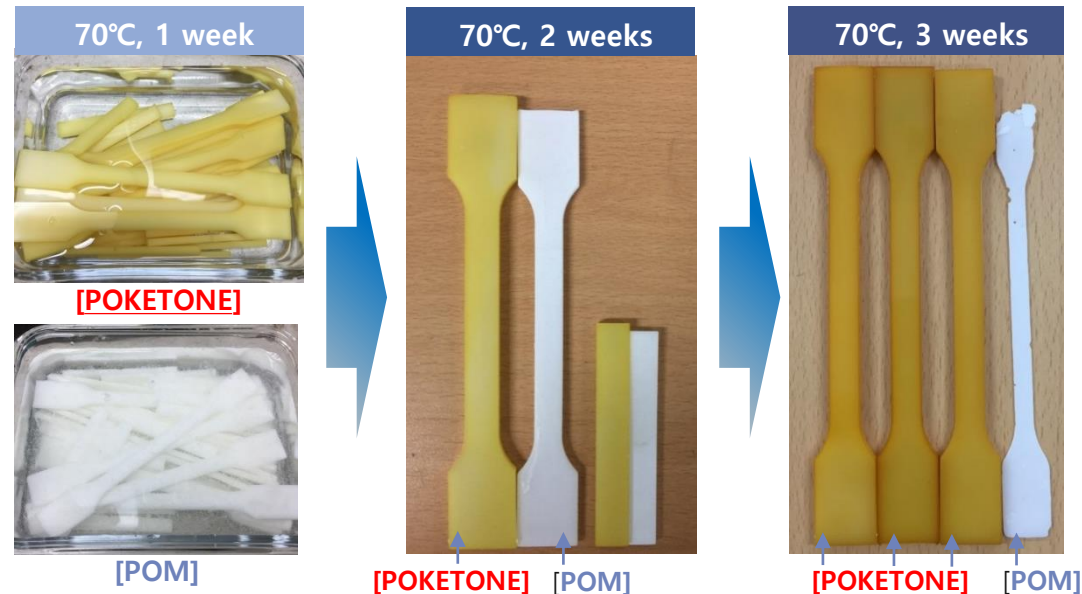
- ✓ Visual & properties change after exposure NaOH 1.5% (Ph 13.7)



+Actual exposure environment : Starting at 71°C
→ Cooling down until finally 31°C for 210hrs

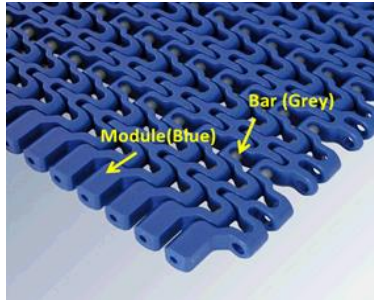
PK M630	Time	Tensile strength (MPa)	Elongation at break (%)	Color ΔE
natural	0 hr	62	151	-
	210 hrs	58	245	0.3
white	0 hr	62	111	-
	210 hrs	57	195	0.1
Blue	0 hr	62	214	-
	210 hrs	57	282	0.4

- ✓ Visual & properties change after exposure chloramines (ph3)



- +Bowl cleaner 100g at water 6 liters, 70°C → appx. 1.63% concentrate
- +POKETONE initial weight is 10.6g per bar → final weight is 10.9g
(**103%** retention rate)
- +POM initial weight is 11.8g per bar → final weight is 2.25g
(**19%** retention rate)

Conveyer Belt Module for Food



- **Summary**
 - Current Material : POM
 - Product : M630F, Modified PK
 - Current State : Completed, Applied
- **Voice Of Customer**
 - Low Abrasion Loss
 - Chemical Resistance to Cleanser
- **Value In Use**
 - Low Abrasion Loss
 - Chemical Resistance (Long lifetime)
 - Impact Strength

Conveyer Belt for Beef Processing



- **Summary**
 - Current Material : Modified POM
 - Product : M630F, M730F
 - Current State : Completed, Applied
- **Voice Of Customer**
 - FDA and Low Abrasion Loss
 - Daily cleaning process(H_2O_2) results in cracks in POM which does not occur in PK
 - Higher cut resistance in operator's cutting process on the conveyor belt
- **Value In Use**
 - Low Abrasion Loss
 - Chemical Resistance(Long lifetime)
 - Impact Strength and Toughness



**Eco-friendly & Non Formaldehyde
Engineering Plastics
For drinking water purifier parts**

POKETONE (Aliphatic Polyketone)

✓ Properties

Properties	Unit	POKETONE M330F / M330F+Color
Density	-	1.24
Melt Index	g/10min	60
Tensile Strength	MPa	60
Elongation at Break	%	> 240
Flexural Strength	MPa	57
Flexural Modulus	MPa	1,400
Impact Strength	KJ/m ²	8
Toughness	-	Best

✓ Test for Hazardous material elution (PK vs POM)

Test Condition : Analysed after 24hr duration of 17EA parts in 90°C hot water, 1L

Poketone(PK) parts for water purifier

Items	Standard		Results	Items	Standard		Results
	Conc.	Unit			Conc.	Unit	
Cd	below 0.005	mg/L	ND	1,1,1-Trichloroethane	below 0.01	mg/L	ND
Se	below 0.001	mg/L	ND	Dichloromethane	below 0.002	mg/L	ND
Pb	below 0.001	mg/L	ND	Cis-1,2-Dichloroethylene	below 0.004	mg/L	ND
As	below 0.001	mg/L	ND	Tetrachloroethylene	below 0.001	mg/L	ND
Cu	below 0.1	mg/L	ND	Epichlorohydrin	below 0.01	mg/L	ND
Cr ⁶	below 0.005	mg/L	ND	Vinyl acetate	below 0.01	mg/L	ND
KMnO ₄	below 1.0	mg/L	ND	Styrene	below 0.002	mg/L	ND
Phenols	below 0.0005	mg/L	ND	1,2-Butadiene	below 0.001	mg/L	ND
Carbon tetrachloride	below 0.0002	mg/L	ND	1,3-Butadiene	below 0.001	mg/L	ND
1,2-Dichloroethane	below 0.0004	mg/L	ND	N,N-Dimethylaniline	below 0.01	mg/L	ND
1,1-Dichloroethylene	below 0.003	mg/L	ND	Formaldehyde	below 0.1	mg/L	ND
1,1,2-Trichloroethane	below 0.0006	mg/L	ND	Toluene	below 0.07	mg/L	ND
Trichloroethylene	below 0.003	mg/L	ND	Xylenes	below 0.05	mg/L	ND
Benzene	below 0.001	mg/L	ND				

POM parts for water purifier

KMnO ₄	below 1.0	mg/L	0.6
Phenols	below 0.0005	mg/L	ND
Carbon tetrachloride	below 0.0002	mg/L	ND
1,2-Dichloroethane	below 0.0004	mg/L	ND
1,1-Dichloroethylene	below 0.003	mg/L	ND
1,1,2-Trichloroethane	below 0.0006	mg/L	ND
Trichloroethylene	below 0.003	mg/L	ND
Benzene	below 0.001	mg/L	ND
Styrene	below 0.002	mg/L	ND
1,2-Butadiene	below 0.001	mg/L	ND
1,3-Butadiene	below 0.001	mg/L	ND
N,N-Dimethylaniline	below 0.01	mg/L	ND
Formaldehyde	below 0.1	mg/L	0.066
Toluene	below 0.07	mg/L	ND
Xylenes	below 0.05	mg/L	ND

Water Purifier Parts

Production	Incumbent Material/Issue	PK Grade/Value
	* mPPO/GF20% * Processability, Taste	* M330F+Color * Processability, Cost
	• mPPO • Processability, Scent, Taste	* M330F * Processability, Cost
	* POM * Formaldehyde issue	* M330F+Color * Non-Formaldehyde
	* ABS * environmental issue, Scent, Taste	* M330F * Non-Formaldehyde
	* POM * Formaldehyde issue	* M330F+Color * Non-Formaldehyde

Water Purifier Fittings



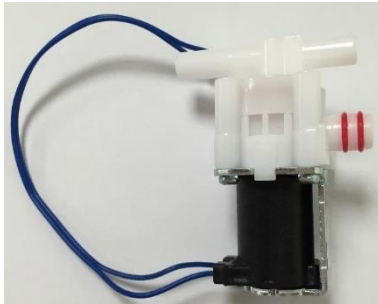
- **Summary**
 - Current Material : POM
 - Product : M330F, Modified M330F
 - Current State : Completed, Applied
- **Voice Of Customer**
 - Formaldehyde Free
- **Value In Use**
 - No Formaldehyde
 - Various Certifications
(FDA, NSF, KTW, WRAS, ACS, W270)
 - High flowability
 - Odor improvement for injection process

Water Purifier tank



- **Summary**
 - Current Material : POM
 - Product : M330F, Modified M330F
 - Current State : Completed, Applied
- **Voice Of Customer**
 - Eco friendly material(No VOCs)
 - Process ability
- **Value In Use**
 - Formaldehyde Free
 - Environment-Friendly Material
 - Green Certificate from Korean Government

Water Purifier Solenoid Valve



- Summary

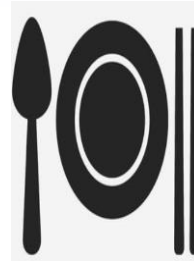
- Current Material : LF POM
- Product : M330F
- Current State : Completed, Applied

- Voice of customer

- Certificate : NSF/ANSI 61
- Formaldehyde Free

- Value In Use

- No VOCs and Formaldehyde Free
- Water contact Certificates
- Low water absorption
- Hydrolysis resistance



**Harmless to human body
Engineering Plastics
For Kitchen ware**

POKETONE (Aliphatic Polyketone)

✓ Properties

Properties	Unit	POKETONE M330F	POKETONE M630F	POKETONE M730F
Density	-	1.24	1.24	1.24
Melt Index	g/10min	60	6	3
Tensile Strength	MPa	60	58	58
Elongation at Break	%	> 240	> 240	> 240
Flexural Strength	MPa	57	53	48
Flexural Modulus	MPa	1,400	1,250	1,200
Impact Strength	KJ/m ²	8	17	19
Toughness	-	Best	Excellent	Excellent



✓ Superior toughness



**[POKETONE food tray
Never Deformed after vehicle load]**



**[Current Material food tray
Completely Cracked after vehicle load]**



POKETONE



Current Material



Eco friendly Tableware



• Summary

- Current Material : Melamine, PC, Stainless
- Product : M330F, M610F
- Current State : Completed, Applied

• Voice of customer

- Safety for Body, Health, especially Kids
- Toughness (Not Broken)
- FDA, LFGB Certification
- Look like Beautiful Foods

• Value In Use

- No harmful ▪Toughness (Not Broken)
- Food Certification (FDA, LFGB, W270..)
- Beautiful, Delicious Food on Plate



Mixer coupler



• Summary

- Current Material : PA66, POM etc.
- Product : M630F
- Current State : Completed, Applied

• Voice of customer

- Toughness, FDA/LFGB Certification
- Wear resistance
- Short time heat resistance

• Value In Use

- Toughness
- FDA, LFGB Certification
- HDT and Wear resistance

Kitchen Tools



- Summary
 - Current Material : PA66
 - Product : M330F
 - Current State : Under Development
(Mass Production Test)
- Voice of customer
 - Toughness, FDA Certification
 - LFGB Certification
 - Short time heat resistance
- Value In Use
 - Toughness
 - FDA, LFGB Certification
 - High HDT (Short time heat resistance)

Cosmetics Packaging (& Dispensing Pump)

POKETONE : New Choice for Cosmetic Industry

POKETONE Polymers(PK) are a new class of engineering plastics- semi-crystalline aliphatic polyketone. The resulting molecular chains are linear, perfectly alternating carbon monoxide and alpha olefin structures that possess a unique balance of strength, chemical resistance and barrier properties, making POKETONE Polymers well-suited for a broad range of applications. PK has lowest extractable than other competing materials, and satisfy regulations for cosmetic industry. This Formaldehyde-Free polymer support customers to avoid any risk of safety. Thanks to its chemical resistance and balanced properties, PK can be a reliable choice for cosmetic contact parts.

Safety and Regulations

POM's formaldehyde(FA) issue is well-known. Many players in cosmetic industry are trying to prohibit formaldehyde and/or formaldehyde donors. Also Tetra-hydrofuran(THF) from PBT is potential issue-maker in cosmetics. The extractable study gives the result as below;

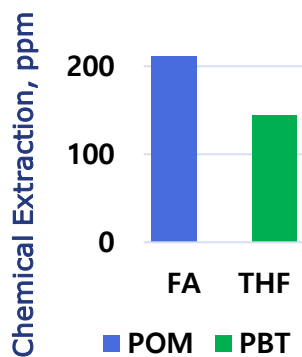


Figure 1. Extractable test at 95°C water for 2 months

The specimen has exposed to 95°C water for 2 months. POM reached 211.3 ppm of FA, and PBT reached 143.9 ppm of THF.

The result of PK gives N.D (Non detectable) for both chemicals.

PK for cosmetics, food contact and medical applications are thoroughly studied and tested for toxicity and other risks. PK satisfies relevant regulations such as;



ISO 10993



Key Properties

Physical Properties	Unit	M330F-S	M33AS1A
Density	g/cm ³	1.24	1.24
Moisture Absorption	%	0.5	0.6
Mold Shrinkage	%	2.0/2.0	2.0/2.0
Mechanical Properties			
Tensile Strength at Yield	MPa	60	60
Elongation at Break	%	300	200
Flexural Strength	MPa	57	56
Flexural Modulus	MPa	1,500	1,400
Charpy Impact Strength	kJ/m ²	8	9
Thermal Properties			
Melting Temperature	°C	222	222
Melt Flow Index	g/10min	60	49

L'OREAL's material Policy - Eradication of Regular POM

L'ORÉAL OPERATIONS

Clichy, April 9th 2019

From: L'Oréal
To: All L'Oréal's plastic packaging suppliers

Object: L'OREAL MATERIAL POLICY – ERADICATION OF REGULAR POM (Polyoxymethylene) IN PACKAGING COMPONENTS (*)

Dear Madam, dear Sir,

L'Oréal Group is deeply engaged to ensure consumer's safety and therefore has taken strong decisions regarding the use of materials, specifically the ones containing or able to release formaldehyde, classified as CMR Carc1B-Muta2 by the European CLP regulation 1272/2008 and prohibited or restricted by several regulations.

Therefore, L'Oréal has initiated several years ago the replacement of regular POM, used in any of its packaging component (in contact or not with formula), and implemented since January 1st 2018 low-VOC POM or other alternative materials thanks to your commitment.

To comply with its material policy, L'Oréal is now requiring to eradicate any POM (regular or low-VOC) when in direct and permanent contact with formula, ie:

- as of January 1st 2020: POM packaging items (*) production are forbidden
- as of June 30th 2020: finished goods production with POM packaging are forbidden

Products from our contract-manufacturing vendors follow the same rule.

To achieve this absolute priority, L'Oréal needs your support with pro-active proposals and tests of new materials to eradicate POM (regular or low VOC) in direct and permanent contact with formula (**). We do encourage to preferably use existing molds, and to develop new molds only if it is not successful. Our packaging teams can already share positive experiences with alternative materials.

We remind you (in agreement with the RPP900, here attached) that any material in contact with the formula (bulk) must be Food Grade.

I thank you to acknowledge receipt of this letter.

Gilles BAUDIN
Head of Packaging Expertise

Monika LETERTRE
Packaging Worldwide Domain
Purchasing Director

(*) <http://www.loreal.com/>

(**) indicative list of components with permanent contact: lipsticks cups, mascara rods, etc ...

indicative list of elements considered as non-permanent contact : Pumps, aerosol valves, and actuators, etc...

Contacts : for Packaging Expertise : Lycia.AOUSSAT@loreal.com
for purchasing : your usual key contacts in L'Oréal organization

1. L'Oreal Group is deeply engaged to ensure customer's safety and therefore has taken strong decisions regarding the use of materials, specifically the ones containing or able to release formaldehyde, classified as.....

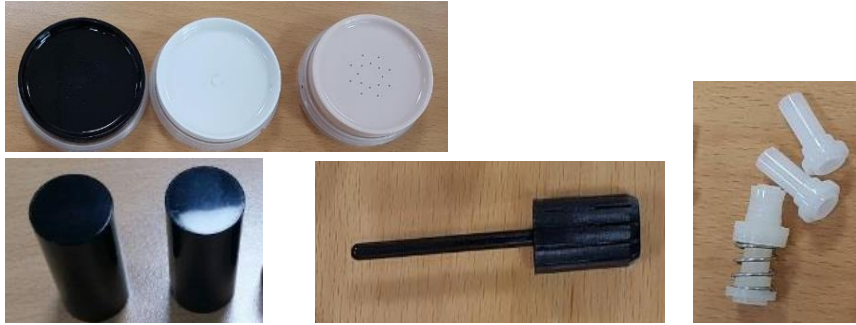
2. To comply with its material policy, L'Oreal is now requiring to eradicate any POM (regular or low-VOC) when in direct and permanent contact with formula, ie :

- as of January 1st 2020 : POM packaging items production are forbidden
- as of June 30th 2020 : finished goods production with POM packaging are forbidden

Products from our contract-manufacturing vendors follow the same rule

3. We remind you (in agreement with the RPP900, here attached) that any material in contact with the formula (bulk) must be Food Grade

Cosmetic Packaging Components



• Summary

- Competing materials : POM, PBT, PP
- PK Grades : M330F, M330F-S
- Customers : L'OREAL, Amore pacific etc.
- Current Status : Commercialized

• Requirements and Values

- Regulatory Compliances (FDA, EU 10/2011 etc.)
- Safety / Formaldehyde, THF free
- Chemical Resistance
- Toughness
- Recycle

Eyebrow Pencil



• Summary

- Eyebrow Pencil
- Competing materials : LF POM, PBT
- PK Grades : M330F, M330F-S
- Current Status : Commercialized

• Requirements and Values

- Regulatory Compliances (FDA, EU 10/2011 etc.)
- Safety / Formaldehyde free
- Chemical Resistance
- Wear Resistance

Cosmetics – Lipstick Part



• Summary

- Competing materials : POM
- PK Grades : M330F
- Current Status : Commercialized

• Requirements and Values

- Regulatory Compliances (FDA, EU 10/2011 etc.)
- Safety / Formaldehyde free
- Chemical Resistance
- Wear Resistance

Dispensing Pump Engine



• Summary

- Competing materials : PA66, POM, PBT
- PK Grades : M330F, M330F-S, M33AS1A
- Current Status : Commercialized for Cosmetics
Under developing for Industrial

• Requirements and Values

- Regulatory Compliances (FDA, EU 10/2011 etc.)
- Safety / Low Extractible and Leachable
- Chemical Resistance
- Wear Resistance
- Toughness, Durability

Air Freshner Plate (for P&G)



• Summary

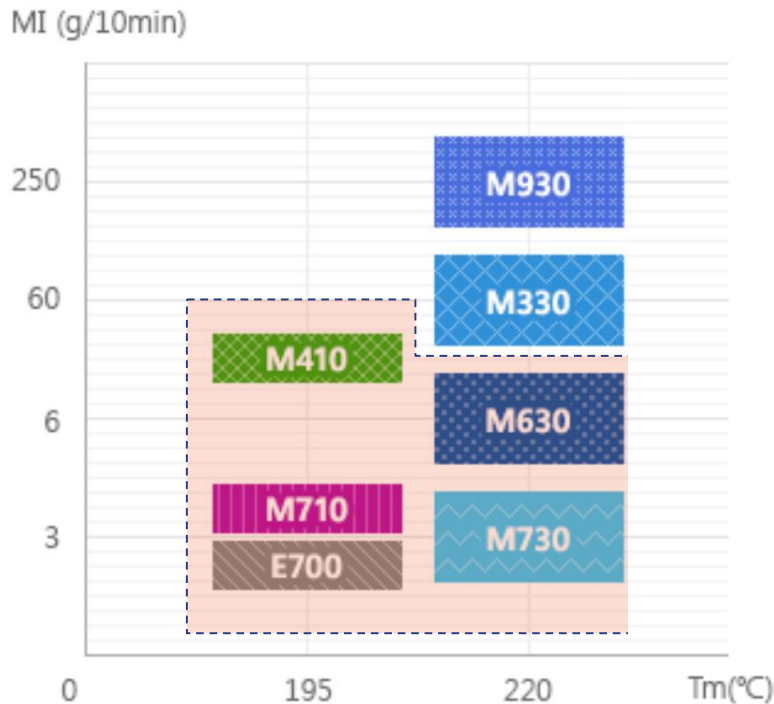
- Competing materials : PA6 + GF 30%
- PK Grades : M330 + GF 30%
- Current Status : Commercialized

• Requirements and Values

- Regulatory Compliances (FDA, EU 10/2011 etc.)
- Chemical Resistance
- Toughness, Elasticity
- Productivity (short cycle time)
- Safety / Formaldehyde, THF free

Pipe (& Extrusions)

Grades



-  M730R Pipes for heat resistance
-  M710F Oil&Gas Pipes for flexibility
-  M410F Monofilament
-  M630A Single layer film
-  E400 Compound for EVOH Blend
Resistance to retort treatment

Key Properties

- Pipes
 - Heat resistance
 - Oil/Chemical resistance
 - Abrasion resistance
 - High Gas barrier
 - Wear Resistance
- Monofilament
 - Heat resistance
 - Chemical resistance
 - Water resistance & hydrolytic stability
 - FDA approval
- Film/Sheet
 - Oxygen Barrier
 - Water resistance & hydrolytic stability
 - FDA approval
 - Resistance to retort treatment

Oil&Gas Pipe Liner



- **Summary**
 - Current Material : PPS, PA12, PVDF, PE-RT
 - Product : M730R, M710F
 - Current State : Completed, Applied
- **Voice of customer**
 - Chemical resistance(CO₂, H₂S, CH₄)
 - Abrasion resistance(Metal[Sucker rod])
 - Gas barrier
- **Value In Use**
 - Heat resistance(120°C) btw PPS & PERT
 - Chemical resistance/Abrasion resistance
 - High Gas barrier

Industrial Monofilament



- **Summary**
 - Current Material : PA612/PA610
 - Product : PK M410F, Thickness: 150~300um
 - Current State : Completed, Applied
- **Voice of customer**
 - Low Moisture absorption
 - Chemical resistance
 - Abrasion resistance/Bend recovery
- **Value In Use**
 - Low Cost
 - Chemical resistance
 - Water resistance & hydrolytic stability

Pipe Fitting&Connector



- Summary

- Current Material : PSU, PA66+GF
- Product : PK M330+GF
- Current State : Completed, Applied

- Voice of customer

- Low Cost/Low Density
- Lower Investment Cost (Mold Change etc.)
- Cycle Time Reduction

- Value In Use

- Low Cost/Low Density
- Short Cycle Time/Processability(Flowability)
- Suitable Mechanical Properties

Pneumatic tube



- Summary

- Current Material : PA12/PA11
- Product : PK M710F Compound
- Current State : Under Development

- Voice of customer

- Flexibility
- Pressure Resistance
- Chemical resistance

- Value In Use

- Gas Barrier
- High Pressure resistance
- Lower Material Price

Oil&Gas Centralizer/Sucker Rod Guide



- Summary

- Current Material : PA66+GF
- Product : PK M930A+GF
- Current State : Under Development

- Voice of customer

- Low Cost
- Chemical resistance(CO₂, H₂S, CH₄)
- Abrasion resistance(Metal[Sucker rod])

- Value In Use

- Wear Resistance
- Oil/Chemical Resistance
- Cost reduction

Sheet



- Summary

- Current Material : PA
- Product : M710F, Thickness: 150~300um
- Current State: Under Development

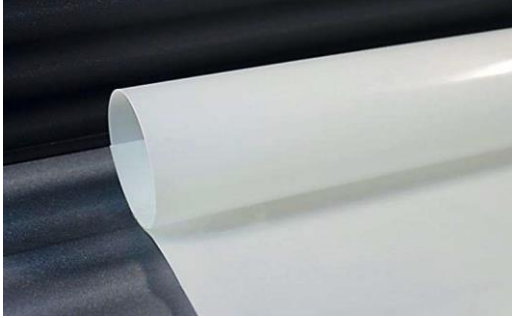
- Voice of customer

- Water resistance & hydrolytic stability
- High Elongation/Toughness
- Low weight

- Value In Use

- Adhesion to metal plate
- Toughness
- Water resistance & hydrolytic stability

Film(Base)



- Summary

- Current Material : EVOH
- Product : PK M630 Thickness: 5~500um
- Current State : Under Development

- Voice of customer

- Low Cost
- Oxygen Barrier
- Safety(Food Contact)

- Value In Use

- Lower Cost than EVOH
- Oxygen Barrier
- FDA approval

Film(Compound for EVOH Blend)



- Summary

- Current Material : EVOH retortable
- Product : PK compound for EVOH Blend
- Current State: Under Development

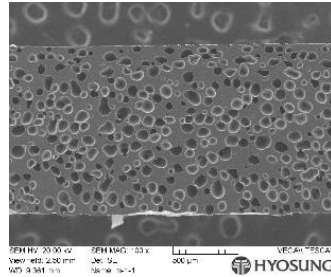
- Voice of customer

- Resistance to retort treatment
- Flexibility
- Oxygen barrier

- Value In Use

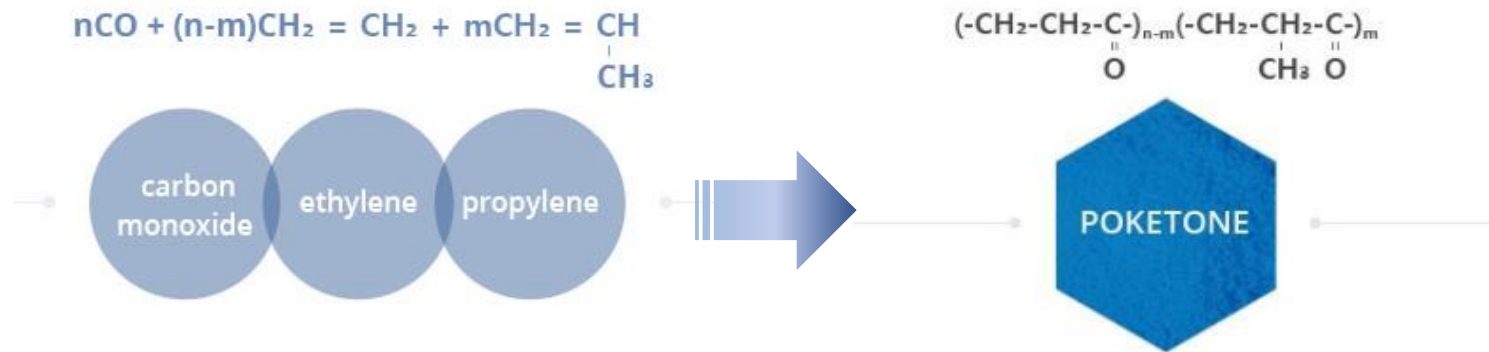
- Low cost
- Resistance to retort treatment
- High Oxygen Barrier

Foam



- **Summary**
 - Current Material : Various Foam Materials
 - Product : PK M710F Density: 600~800g/L
 - Current State : Under Development
- **Voice of customer**
 - Safety(Non-toxic)
 - Chemical Resistace
 - Abrasion resistance
- **Value In Use**
 - FDA Approved, USP Class VI
 - Chemical resistance
 - Abrasion resistance/Low moisture absorption

Automotive



- ❑ Excellent Chemical Resistance for Fuel parts vs PA6, PA66, PBT
- ❑ Better NVH(Noise, Vibration, Harshness) Performance vs PA6, PA66, PBT
- ❑ Low VOCs, Low Odor for Interior Parts vs ABS, POM
- ❑ Better Scratch/Wear resistance for Interior Parts vs ABS, POM
- ❑ Better Dimensional Stability at various Environmental Conditions vs PA6, PA66, POM
- ❑ Excellent impact performance vs PA6, PA66, PBT, POM
- ❑ Superior Hydrocarbon Barrier for Fuel Tube vs PA12

Connector (for Gasoline/Diesel & Electric)



• Summary

- Current Material : PBT
- Product : M330A (Natural, White, Gray, Black)
- Current State : Commercialized

• Voice Of Customer

- High Impact Strength
- Dimensional Stability

• Value In Use

- Better Impact Resistance at low temperature
- Better Processability for Thinwall
- Weight Reduction

VESS (Virtual Engine Sound System) Housing



• Summary

- Current Material : PBT+GF30
- Product : M33AX0A-BK0
- Current State : Commercialized

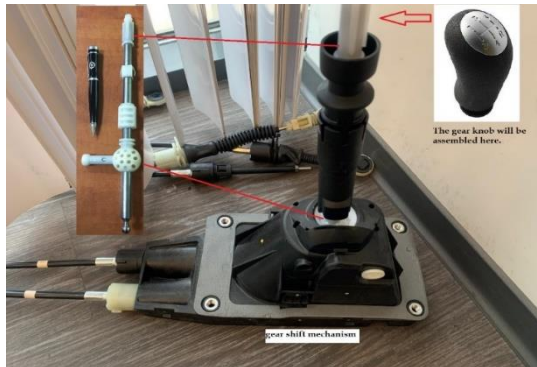
• Voice Of Customer

- High heat resistance and Low modulus
- Weight Reduction

• Value In Use

- Good sound quality at low and high temperature
- High Impact Strength and Resilience

Bearing in Gear Shift Mechanism



• Summary

- Current Material : POM
- Product : M330A
- Current State : Commercialized

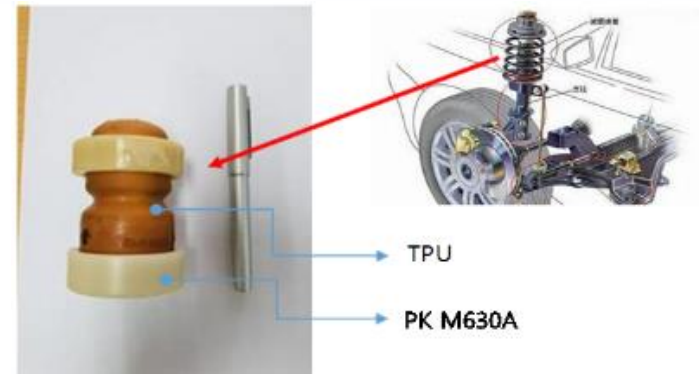
• Voice Of Customer

- High Impact Resistance

• Value In Use

- Good Impact resistance
- Better Resilience

Damping Ring



• Summary

- Current Material : POM
- Product : M630A
- Current State : Commercialized

• Voice Of Customer

- Good Ductility

• Value In Use

- Better Toughness and Damping Effect
- Weight Reduction

Fastener and Clip



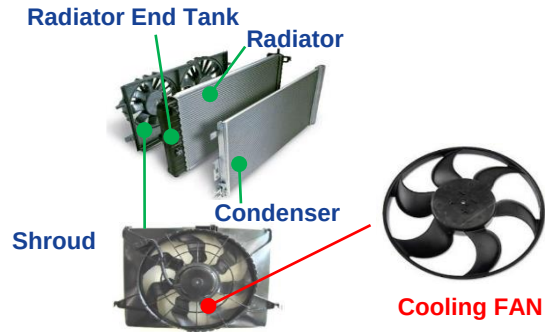
- **Summary**
 - Current Material : POM
 - Product : M330A
 - Current State : Commercialized
- **Voice Of Customer**
 - VOCs (Volatile Organic Compounds) Reduction
 - Low odor
- **Value In Use**
 - Satisfied strengthened VOCs Regulation
 - Odorless
 - High Impact Resistance
 - Weight Reduction

Headlamp Washing System



- **Summary**
 - Current Material : POM
 - Product : M630A
 - Current State : Commercialized
- **Voice Of Customer**
 - Good Chemical Resistance
 - Water Pressure Resistance
- **Value In Use**
 - Better Chemical Resistance
 - Good Water Pressure Resistance
 - Weight Reduction

Cooling Fan



• Summary

- Current Material : PA66-(GF+MD) 40%
- Product : PK+PA6-(GF+GB) 27%
- Current State : Under Developing

• Voice Of Customer

- Improved NVH performance
- Good mechanical properties

• Value In Use

- Weight Reduction : 8%
- Noise reduction : 5dB
- Better Dimensional stability

Wheel Sensor Cap



• Summary

- Current Material : PA66+GF35%
- Product : M33AG6A-BK0
- Current State : Under Developing

• Voice Of Customer

- Low Water Absorption
- Good Flowability

• Value In Use

- Low Water Absorption & Good Dimensional Stability
- Good Physical Property Retention

Airbag Mount Clip



- **Summary**

- Current Material : LOF POM
- Product : M630A
- Current State : Under Developing

- **Voice Of Customer**

- Low VOCs, Low Formaldehyde (<100ppm)
- Good Wear Resistance

- **Value In Use**

- Formaldehyde free
- Excellent Impact for Airbag Deployment
- Better Wear Resistance

MDPS Powerpack Cover



- **Summary**

- Current Material : PBT+GF30%
- Product : M33AG6A-BK0
- Current State : Under Developing

- **Voice Of Customer**

- Field complaint on NVH Issue
- Good Impact Resistance(Charpy > 16KJ/m2)

- **Value In Use**

- Better NVH Performance
- Weight Reduction

Fuel Pump Flange



- **Summary**

- Current Material : POM, PPA
- Product : M630R
- Current State : Under Developing

- **Voice Of Customer**

- MCUT 100°C
- Better Property Retention after various Fuel Exposure
- Good Chemical Resistance for Fluids (Fuels, Oils..)

- **Value In Use**

- Excellent Fuel Resistance
- Better Dimensional stability
- Positioning between POM & PPA (Heat & System cost)

Gear & Conveyer

ATM Gear



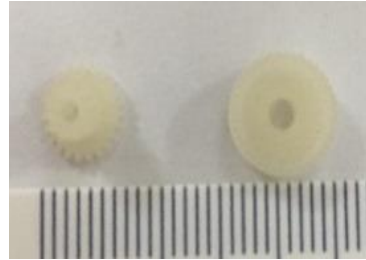
- **Summary**
 - Current Material : POM
 - Product : M330, M630, PK+Wear Reinforcement
 - Current State : Completed, Applied
- **Voice Of Customer**
 - Equivalent Wear Resistant
- **Value In Use**
 - Equivalent Wear Resistant
 - Low Weight (Low Density)
 - Flowability - Cycle Time Reduction
 - Chemical Resistance : Against Grease etc.

Gear for motor and running machine



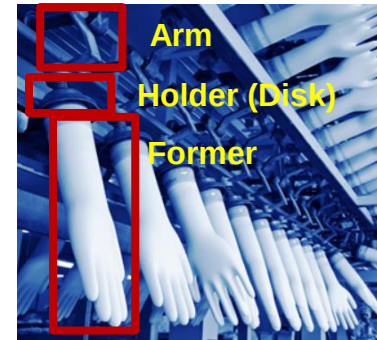
- **Summary**
 - Current Material : POM
 - Product : M630
 - Current State : Completed, Applied
- **Voice Of Customer**
 - Formaldehyde free
 - Less noise and Wear resistance
- **Value In Use**
 - Eco friendly/VOCs Free
 - Wear Resistance
 - Less noise

Portable Photo-Printer Gear



- Summary
 - Current Material : POM
 - Product : M630
 - Current State : Commercialized
- Voice Of Customer
 - Less noise and Wear resistance
 - Lower Stiffness (vs POM)
 - Less Vibration - Better Picture Quality
- Value In Use
 - Less Noise
 - Wear Resistance
 - Impact resistance and Flexability

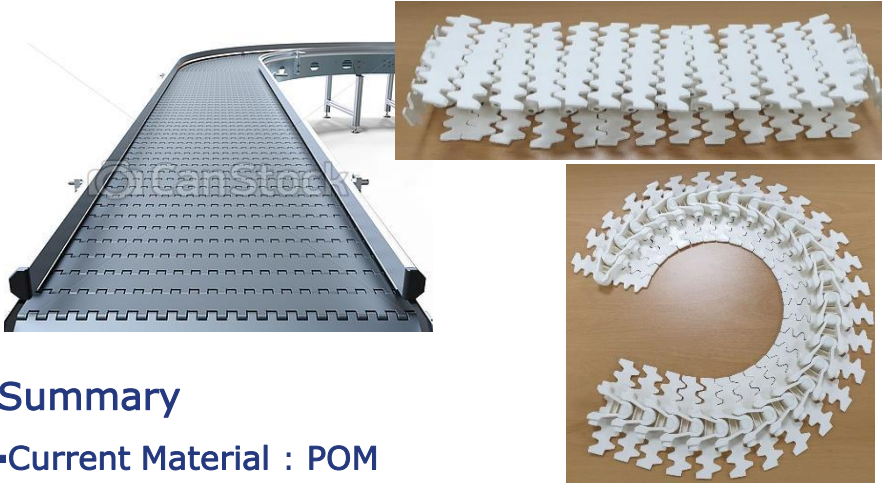
Glove conveyor



- Summary
 - Current Material : PA66+GF
 - Product : M330+GF
 - Current State : Ready to be commercialized
- Voice Of Customer
 - Chemical Resistance
 - Wear resistance
- Value In Use
 - Chemical Resistance
 - Impact Strength
 - Low Water Absorption



Industrial Conveyor belt



- **Summary**

- Current Material : POM
- Product : M330, M630
- Current State : Completed, Applied

- **Voice Of Customer**

- Low Abrasion Loss
- Long-term stability
- No VOCs(No Formaldehyde)

- **Value In Use**

- Low Abrasion Loss
- No VOCs(No Formaldehyde)
- Impact Strength and Toughness

Conveyor Belt bushing



- **Summary**

- Current Material : PA66, PA6+GF20%
- Product : M330, M630
- Current State : Completed, Applied

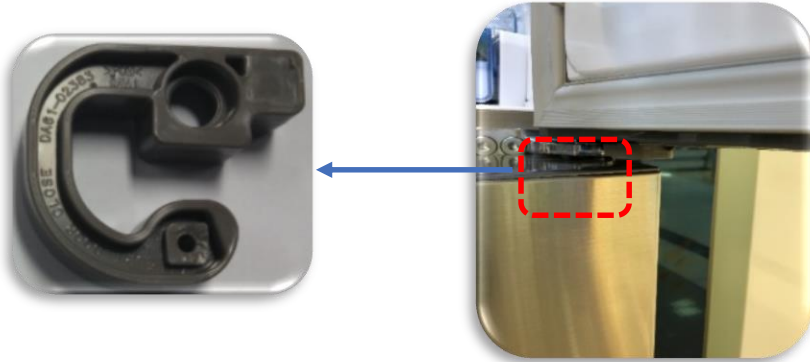
- **Voice Of Customer**

- Low Abrasion Loss
- Hydrolysis resistance and Dimensional stability

- **Value In Use**

- Low Abrasion Loss
- Hydrolysis resistance
- Dimensional stability

Door Closer for Refrigerator



- Summary

- Current Material : POM
- Product : M330+Wear/Impact Reinforcement
- Current State : Completed, Applied

- Voice Of Customer

- Wear resistance
- Noise reduction

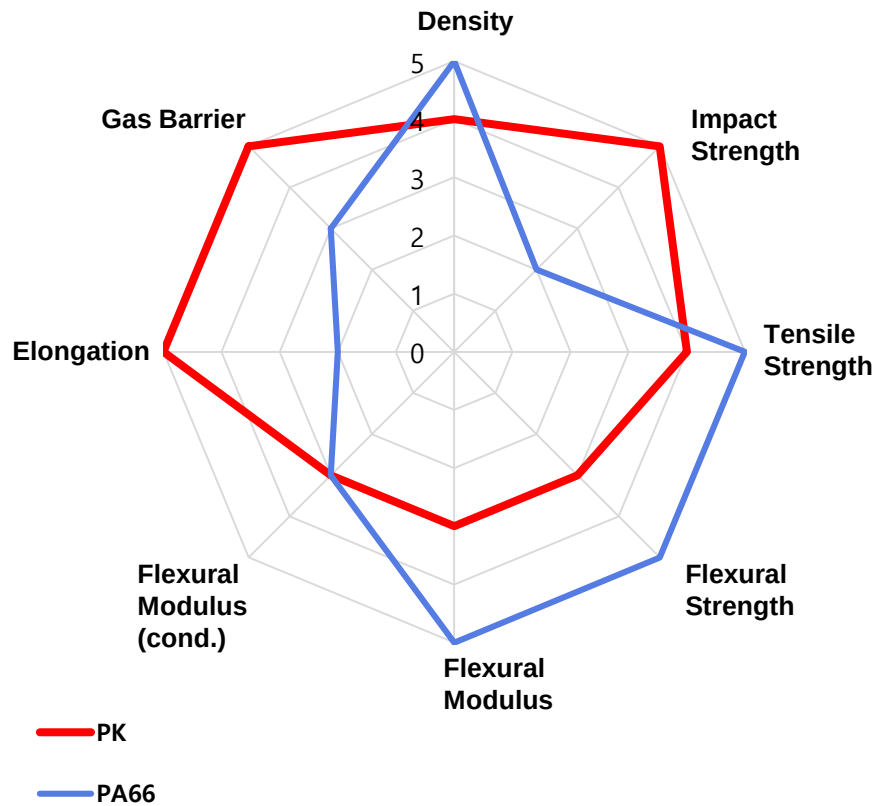
- Value In Use

- Noise Reduction
- Equivalent or Better Wear Property

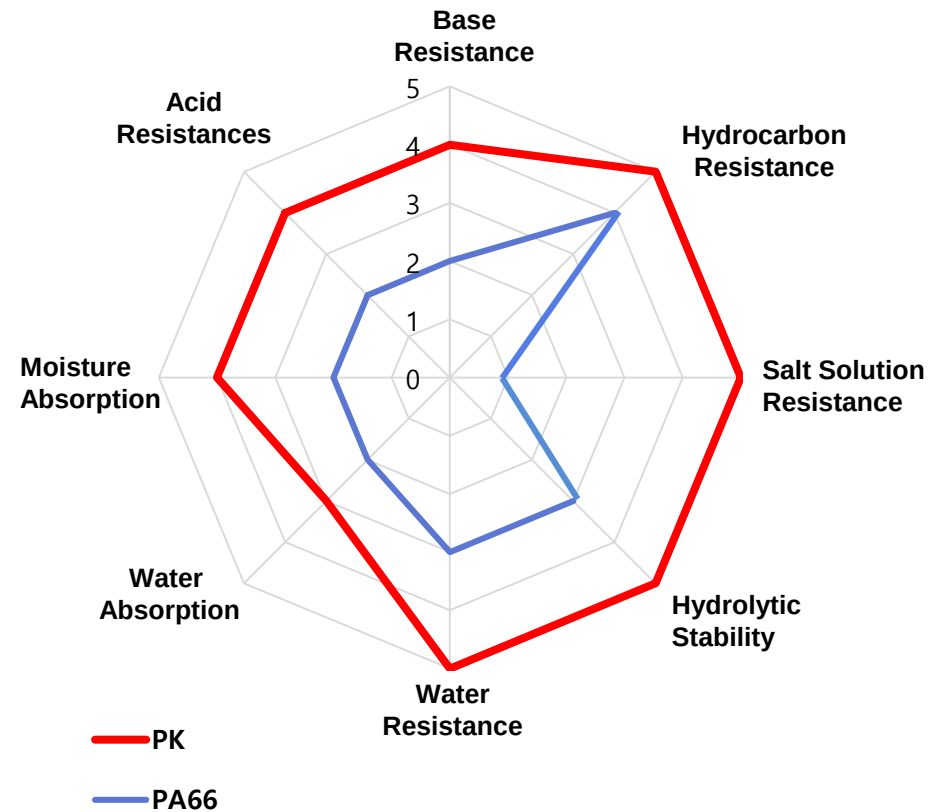
Industrial

□ POLYKETONE has well-balanced physical properties with low moisture absorption

Mechanical Properties



Chemical & Water Resistance



Caster/Wheel



• Summary

- Current Material : PA6/66, POM
- Product : M330, M630, PK+GF
- Current State : Completed, Applied

• Voice Of Customer

- Chemical resistance to acid
- 3 Ton Pressure Test
- 100,000 Cycles Test at 120kg

• Value In Use

- Low Water Absorption
- Low Temperature Impact Strength
- Wear Resistance

Bobbin



• Summary

- Current Material : PA66
- Product : M330, M630
- Current State : Completed, Applied

• Voice Of Customer

- Cost reduction
- Dimensional Stability
- Wear Resistance and Heat resistance

• Value In Use

- Dimensional Stability
- Heat Resistance
- Wear Resistance
- Impact Strength

Boiler Exhaust Heat Exchanger



• Summary

- Current Material : Stainless Steel
- Product : M930+GF
- Current State : Completed, Applied

• Voice Of Customer

- Cost, Weight Reduction
- Better Mechanical Properties compared to competing Material (PA66/GF30%)
- Good Chemical Resistance
 - No Crack (PA66 - Crack by Condensate)

• Value In Use

- Good Chemical Resistance
- Heat resistance and toughness

Bearing for Dish Washer



• Summary

- Current Material : Modified POM
- Product : M330, M330+Wear Reinforcement
- Current State : Completed, Applied

• Voice Of Customer

- Low Abrasion Loss
- Chemical Resistance
- Impact Strength

• Value In Use

- Wear Resistance
- Dimensional Stability and Low water absorption
- Chemical Resistance

Water heater



- Summary
 - Current Material : PA66+GF 30%
 - Product : M330+GF
 - Current State : Developing
- Voice Of Customer
 - Water contact certificate
 - Cost reduction
 - Dimensional Stability
 - Heat resistance
- Value In Use
 - Dimensional Stability
 - Chemical Resistance
 - Heat Resistance

Glasses frame



- Summary
 - Current Material : POM
 - Product : M330, M630, M330+Impact Reinforcement
 - Current State : Completed, Applied
- Voice Of Customer
 - Cost reduction
 - Dimensional Stability
 - Wear Resistance and Heat resistance
- Value In Use
 - Dimensional Stability
 - Chemical Resistance
 - Wear Resistance and Impact Strength

Chair, Seat Cam



• Summary

- Current Material : POM
- Product : M330, M630, Modified PK
- Current State : Completed, Applied

• Voice Of Customer

- Less noise and Wear resistance
- Dimensional Stability

• Value In Use

- Less Noise
- Wear Resistance
- Impact resistance

Helmet Ratchet



• Summary

- Current Material : Lubricated POM
- Product : M330, M630
- Current State : Completed, Applied

• Voice Of Customer

- Less Noise and Low odor(Formaldehyde Free)
- Resilience & Impact strength
- 10,000 times operating test, Dropping
Impact test (50°C/-20°C, 4hr)
- Noise Test OK

• Value In Use

- Less Noise and Wear Resistance
- Impact resistance

Sprinkler for Irrigation



- **Summary**
 - Current Material : PBT
 - Product : M630+UV Reinforcement
 - Current State : Completed, Applied
- **Voice Of Customer**
 - Hydrolysis and Chemical Resistance
 - Chemical Resistance
- **Value In Use**
 - Hydrolysis Resistance
 - Chemical Resistance
 - Impact Strength
 - Pressure Resistance (Resilience)

Water Flow Filter



- **Summary**
 - Current Material : PA66+GF 30%
 - Product : M330+GF 30%
 - Current State : Completed, Applied
- **Voice Of Customer**
 - Hydrolysis and Chemical Resistance
 - Chemical Resistance
- **Value In Use**
 - Hydrolysis Resistance
 - Chemical Resistance
 - Impact Strength
 - Pressure Resistance (Resilience)

Toilet Urinal Part



• Summary

- Current Material : mPPO+GF20%
- Product : M330+GF 10%
- Current State : Completed, Applied

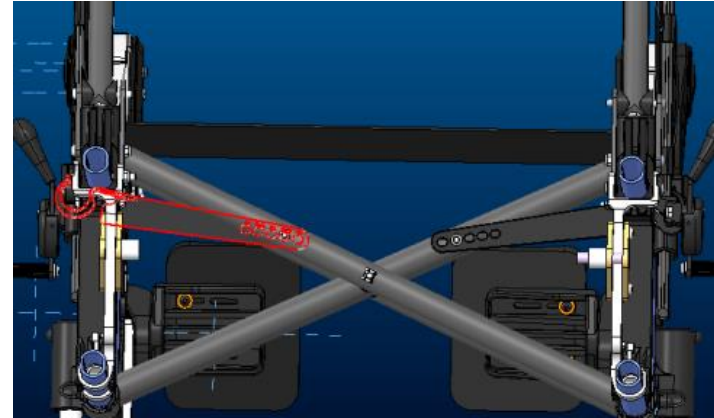
• Voice of customer

- Chemical Resistance
- Ultrasonic Welding

• Value In Use

- Chemical Resistance
- High Pressure Impact Strength (9kgf)

Wheelchair fixing part



• Summary

- Current Material : PA66
- Product : M330
- Current State : Completed, Applied

• Voice of customer

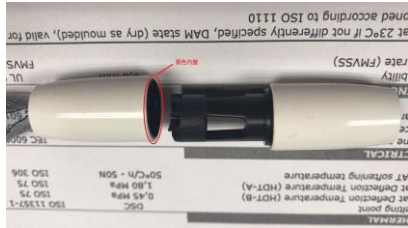
- Toughness and Low water absorption

• Value In Use

- Toughness
- Low water absorption
- Hydrolysis resistance



Electronic cigarette part



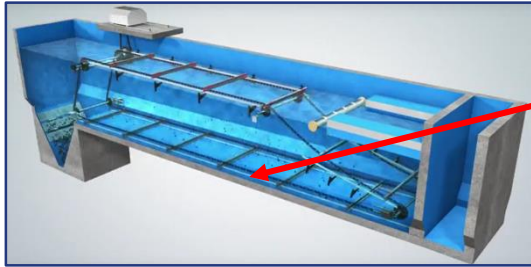
- **Summary**
 - Current Material : PC, PCTG
 - Product : M330
 - Current State : Completed, Applied
- **Voice of customer**
 - Certificate(FDA) and Safety to human body
 - Dimensional stability
 - Chemical rsistance
- **Value In Use**
 - Certificate(FDA) and Safety to human body
 - Dimensional stability
 - Chemical rsistance

Industrial O-ring (Hydraulic O-ring)



- **Summary**
 - Current Material : PA66
 - Product : M330, M630
 - Current State : Developing
- **Voice of customer**
 - High Impact Strength
 - Processability, Dimension Stability
- **Value In Use**
 - Toughness
 - Dimension Stability, Hydrolysis Resistance

Waste Water Treatment Sludge Chain



• Summary

- Current Material : PA/GF 30%, PPA/GF 25%
- Product : M330+GF 30%
- Current State : Completed, Applied

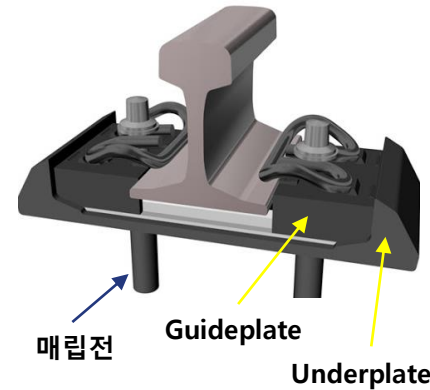
• Voice of customer

- Chemical Resistance
- Dimensional stability under water condition
- 3 Link Pulling Force > 3.5 Ton

• Value In Use

- High Chemical Resistance , Dimension Stability
- 3 Link Pulling Force = 3.5 Ton (PA = 3.2 Ton)
- High Wear Resistance

Railway Part (Korea)



• Summary

- Current Material : PA66, PA6+GF
- Product : M630, M330+GF
- Current State : Completed, Applied

• Voice of customer

- Impact strength, Tensile Strength
- Electrical Insulation, Dimensional stability

• Value In Use

- High elongation
- Dimensional stability under water condition
- Impact strength

Water Purifier tank



- **Summary**
 - Current Material : POM
 - Product : Base PK or Modified PK
 - Current State : Completed, Applied
- **Voice Of Customer**
 - Eco friendly material(No VOCs)
 - Process ability
- **Value In Use**
 - Formaldehyde Free
 - Environment-Friendly Material
 - Green Certificate from Korean Government

Body & Body Cap for Water Pump



- **Summary**
 - Current Material : m-PPO(GF20%)
 - Product : PK/GF30 Black color
 - Current State : Completed, Applied
- **Voice Of Customer**
 - No crack after pressure cycle test
 - Equivalent or Better Wear Property
 - 700,000 cycles of pressure test at cold/hot water
- **Value In Use**
 - Hydrolysis and Chemical Resistance
 - Impact Strength
 - Pressure Resistance (Resilience)

Pump Impeller



- Summary
 - Current Material : PA12
 - Product : M330, M330+Impact Reinforcement
 - Current State : Completed, Applied
- Voice Of Customer
 - Eco friendly material(No VOCs)
 - Wear Resistance
 - Certificate(NSF, ACS, WRAS, etc.)
 - Chemical resistance
- Value In Use
 - Wear Resistance to sand
 - Chemical resistance(CaO, CaS etc.)

Faucet



- Summary
 - Current Material : POM, m-PPO
 - Product : M330, M630
 - Current State : Completed, Applied
- Voice Of Customer
 - Eco friendly material(No VOCs)
 - Wear Resistance
 - Certificate(NSF, ACS, WRAS, etc.)
- Value In Use
 - Formaldehyde Free
 - Environment-Friendly Material
 - Green and water Certificates

Faucet



- **Summary**
 - Current Material : POM, m-PPO
 - Product : M330
 - Current State : Completed, Applied
- **Voice Of Customer**
 - Eco friendly material(No VOCs)
 - Wear Resistance
 - Hydrolysis Resistance
- **Value In Use**
 - Formaldehyde Free
 - Dimensional Stability
 - Wear and Hydrolysis Resistance
 - Impact Strength

Roller



- **Summary**
 - Current Material : POM, m-PPO
 - Product : M730A
 - Current State : Completed, Applied
- **Voice Of Customer**
 - Eco friendly material(No VOCs)
 - Wear Resistance
 - Hydrolysis Resistance and Dimensional stability
- **Value In Use**
 - Dimensional Stability
 - Wear and Hydrolysis Resistance
 - Impact Strength

Bus bar for mine



- **Summary**
 - Current Material : PESU
 - Product : M930+GF+V2
 - Current State : Completed, Applied
- **Voice of customer**
 - Chemical resistance
 - FR Property
- **Value In Use**
 - Chemical resistance
 - HDT(Heat Deflection Temperature)
 - Wear resistance
 - Hydrolysis resistance

Water Meter



- **Summary**
 - Current Material : LF POM or PA6/66
 - Product : M330+GF
 - Current State : Completed, Applied
- **Voice of customer**
 - Abrasion Resistance for accuracy
 - Formaldehyde Free
- **Value In Use**
 - Formaldehyde Free
 - Abrasion Resistance for accuracy
 - Hydrolysis Resistance
 - Processability and Dimensional stability

Mixer coupler



- Summary

- Current Material : PA66, POM etc.
- Product : PK M630F
- Current State : Commercialized

- Voice of customer

- Toughness, FDA Certification, LFGB Certification
- Wear resistance
- Short time heat resistance

- Value In Use

- Toughness
- FDA, LFGB Certification
- HDT and Wear resistance

Perfume Spray Part



- Summary

- Current Material : POM, PA
- Product : PK M330A
- Current State : Completed, Applied

- Voice of customer

- High Impact Strength
- Low VOCs

- Value In Use

- Toughness
- Low VOCs

A Heald for loom



- Summary

- Current Material : POM
- Product : M930
- Current State : Commercialized

- Requirements and Values

- High flowability (Processability)
- Toughness (Not broken)
- Wear resistance

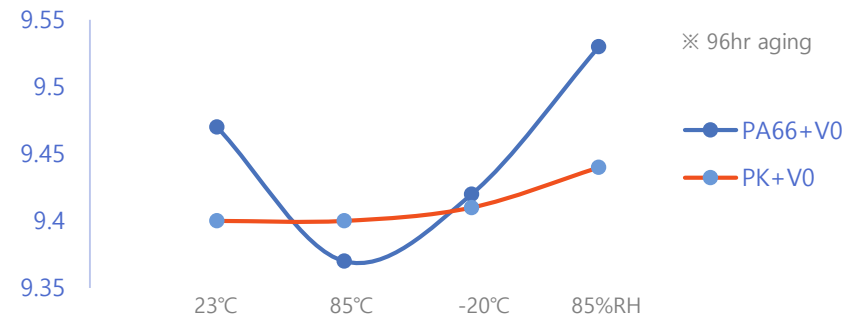
E & E

(Electrical & Electronic)

IEC 60335-1 Standard Compliance

- POKETONE is tested under IEC 60335-1 : Safety of household electrical appliances, and all the results is acceptable
- Especially, POKETONE connectors has passed Glow Wire Test at 750°C (IEC 60695-2-11) with no ignition
- Glow Wire Test has performed to about 60 kinds of connectors - All the results is "No Ignition"

Dimensional stability under high humidity & heat



POKETONE PROPERTIES

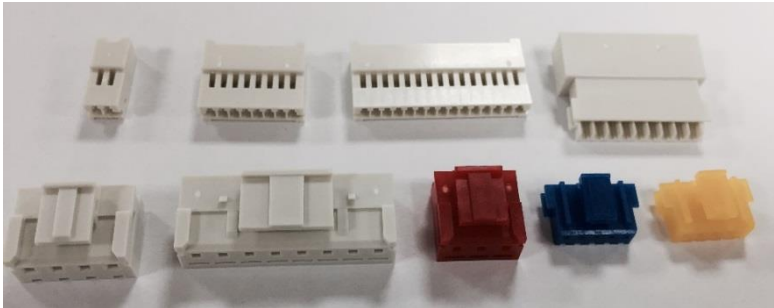
Properties	Unit (ISO)	PK	PK+GF5	PK+GF15	PK+GF30
Density	g/cm ³	1.26	1.32	1.38	1.47
Water Absorption	%	0.45	0.4	0.35	0.3
Mold Shrinkage	%, MD/TD	1.6/1.6	0.7/1.3	0.2/1.0	0.1/0.7
Impact Strength	kJ/m ²	6	7	9	12
Tensile Strength at Yield	MPa	50	57	100	140
Elongation at Break	%	40	13	3.5	3.5
Flexural Modulus	MPa	1,800	3,200	4,500	6,600
HDT (@ 1.82MPa)	°C	115	195	205	205
Flammability	UL94	V0(0.8T)	V0(0.8T)	V0(0.8T)	V0(0.8T)
GWFI	°C	960	960	960	960
GWIT	°C	825	825	825	825
GWT @ 750°C, Flame < 2s	Pass/Fail	Pass	Pass	Pass	Pass

5. Test Result

5.1 Glow-wire Test Result

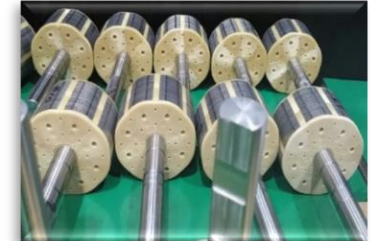
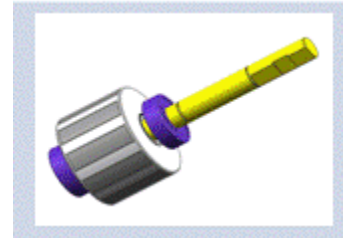
Test Item	Test Condition & Method	Criterion	Test Result	
Glow Wire	Components made of insulating materials that come in contact with or maintain current-carrying components : 750 t	1) There is no ignition or If flames or glowing combustion of the test specimen extinguish within 30 s after removal of the glow wire 2) The specified layer placed underneath the test specimen does not ignite	Sample	Result
			YH396-03JRZ	No ignition
			YH396-04JRZ	No ignition
			YH396-05JRZ	No ignition
			YH396-07JRZ	No ignition

Connector for Home Appliances



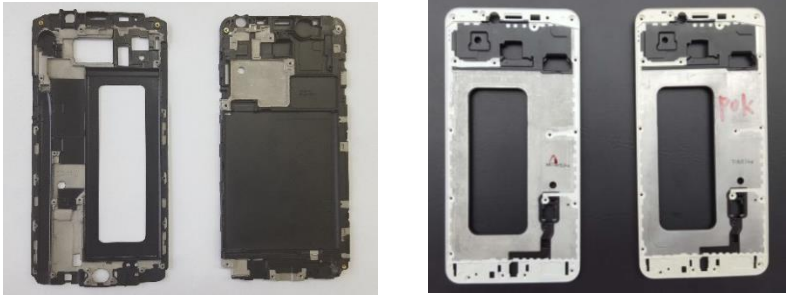
- **Summary**
 - Current Material : PA66+V0, PC/PET+V0
 - Product : M330+V0, M330+GF+V0
 - Current State : Completed, Applied
- **Voice of customer**
 - GWT 750°C w/ no Ignition
 - GWFI $\geq$ 850°C, GWIT $\geq$ 775°C
- **Value In Use**
 - GWT 750°C w/ no Ignition
 - Better Flexibility, High Processability
 - Annealing Process not required
 - Dimensional stability under water condition
 - High Impact Strength

Air conditioner Motor Rotor



- **Summary**
 - Current Material : PBT+GF 30%
 - Product : M330+GF 30%
 - Current State : Completed, Applied
- **Voice of customer**
 - Mechanical Strength
 - Attachment with Insert (Steel)
 - Thermal Impact Strength
- **Value In Use**
 - Better Thermal Impact Strength
 - Dimensional & Performance stability under high humidity and heat

Smartphone Bracket



• Summary

- Current Material : PC+GF 20~30%
- Product : M330+GF 50%
- Current State : Completed, Applied

• Voice of customer

- Mechanical Strength
- High Processability, low dielectric rate

• Value In Use

- High Flexural & Tensile Strength
- Better Flexibility, High Processability

	UNIT	PC + GF20%	PC + GF30%	POK + GF50%	PPA GF50%
충격강도	Kgfcm/cm	20	14	13	25.2
인장강도	Kgf/cm2	950	1,375	1,560	2,158.9
굴곡강도	Kgf/cm2	1,400	1,800	2,400	3,400.6

Headphone



• Summary

- Current Material : PP
- Product : M330
- Current State : Completed, Applied

• Voice Of Customer

- Low temperature impact strength
- Flexability

• Value In Use

- Low Temperature Impact Strength
- Flexibility
- Mechanical Strength

Watt-hour meter



- Summary
 - Current Material : PC+GF+V0
 - Product : M330+GF+V0
 - Current State : Under Developing
- Voice of customer
 - Environment-Friendly Material
 - Green Certificate from Korean Government
- Value In Use
 - GWT 750°C w/ no Ignition
 - Better Flexibility, High Processability
 - Dimensional stability under water condition
 - High Impact Strength

Medical

✓ Certification



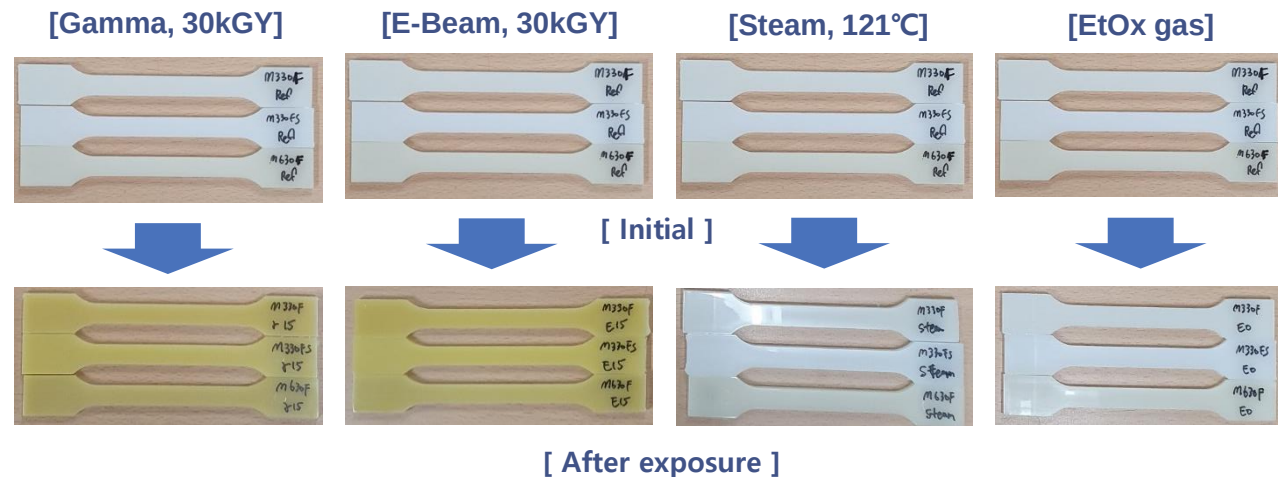
+ ISO 10993 has been certified cytotoxicity, sensitization and intracutaneous reactivity for intact skin.

✓ POKETONE properties after sterilization exposure

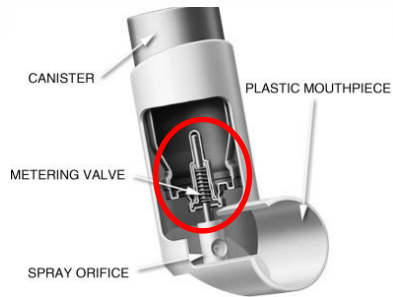
Grade	Properties	Initial	Gamma		E-Beam 30kGY	Steam 121°C	EtOx
			VD MAX 15, 30kGY	VD MAX 25,50kGY			
M330F M330FS	Tensile Strength [MPa]	61	62	62	61	65	62
	Elongation at break [%]	239	235	253	252	107	247
	Flexural Modulus [MPa]	1,692	1,710	1,725	1,689	1,461	1,712
M630F M630FS	Tensile Strength [MPa]	59	60	60	60	67	60
	Elongation at break [%]	265	269	278	265	165	263
	Flexural Modulus [MPa]	1,529	1,604	1,594	1,587	1,550	1,607

+ Tested by Hyosung R&D lab, and 3rd party test center in Korea

+ Steam test is ISO 17665-1,2 at 121°C, 15min / EtOx test is ISO 11135-1,2, 50°C, Rh 50%, 5hr



Metering Valve for Inhalers



- Current Material : Low VOCs POM, FDA PBT
- Polyketone : PK M330F-S
- Current State : Under field test

- Voice of customer & value in use
 - No contain harmful component
 - FDA, USP Class VI, ISO 10993 certified
 - Stable properties after exposure of sterilization (Gamma, E-beam, Steam, EtOx)
 - Non toxicity extraction
 - No VOCs (Volatile Organic compounds)
 - Formaldehyde Free and No odor
 - Abrasion Resistance ▪ Chemical resistance
 - High Toughness

Nasal Spray Pumps



- Current Material : Various (PP, POM, PA66 etc)
- Polyketone : PK M330F-S
- Current State : Under property test

Insulin pen



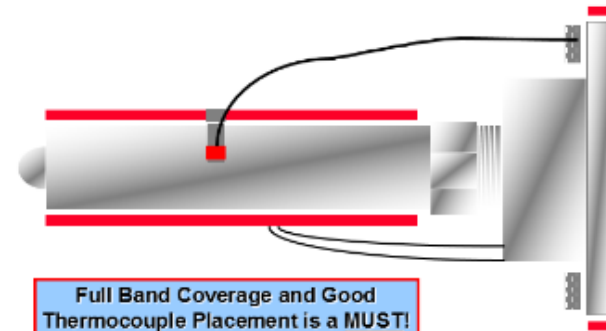
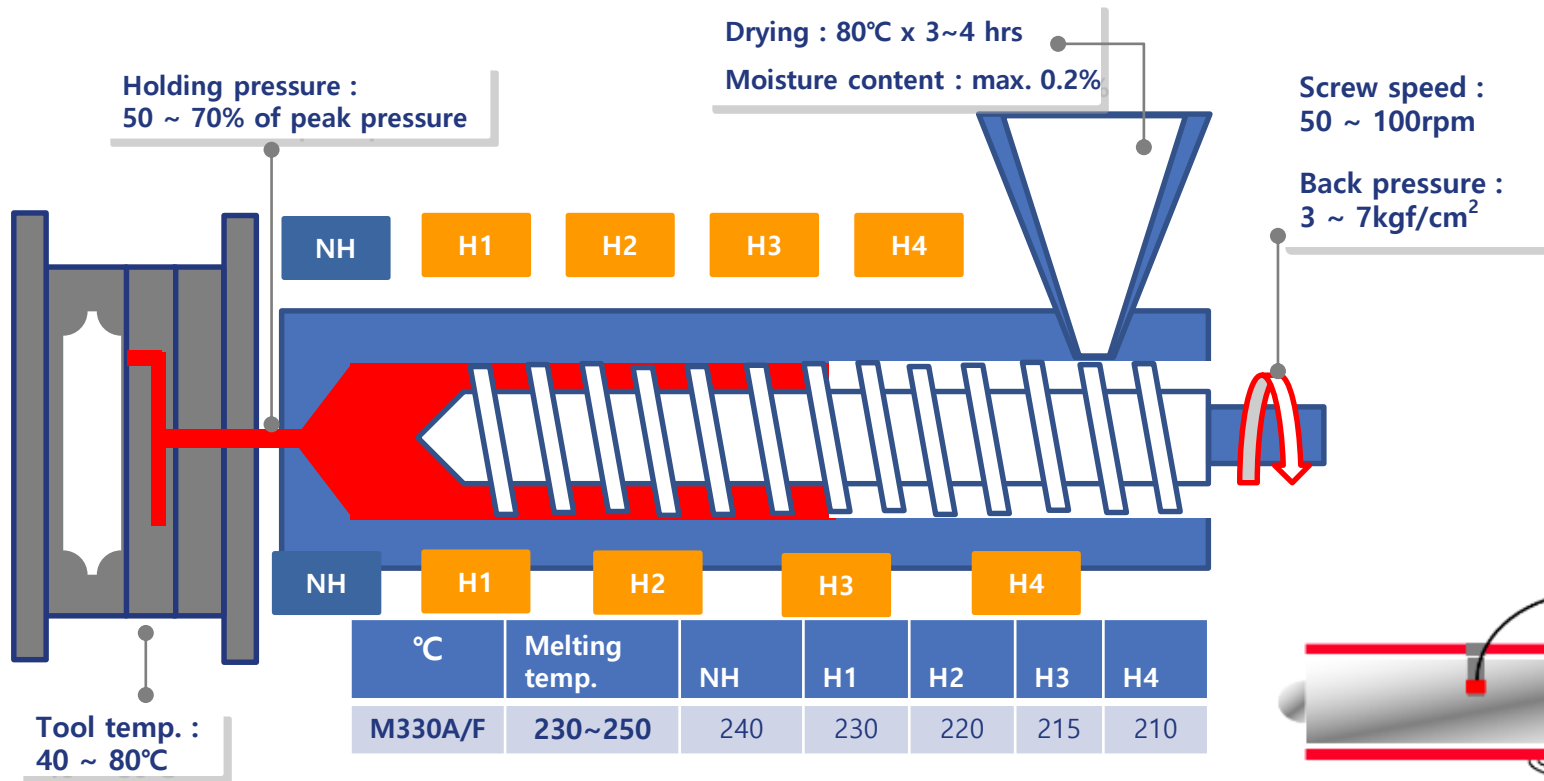
- Current Material : Low VOCs POM, FDA PBT
- Polyketone : PK M330F-S
- Current State : Under property test

Process Guide

(Injection Molding)

Injection Molding Guide

POKETONE Base Grade

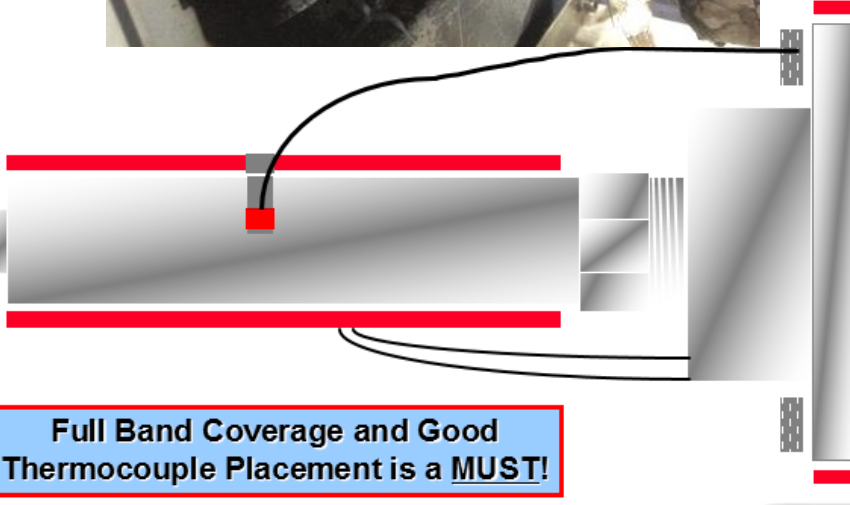


- Well-controlled heated nozzles as using enough capacity heater and separated thermocouple are strongly recommended to prevent freeze-off issue at nozzle due to small sized nozzle orifice or rapid solidification of POK.
- Should be thoroughly purged at processing temperature with purging material such as PCTG, HDPE, GPPS or other commercially available purging compounds.



- ✓ Recommended nozzle orifice size
 - Small sized m/c (200T less): min. Ø3.5mm
 - Mid sized m/c (200~450T): min. Ø4.0mm
 - Mid~Large m/c (500T over): min. Ø5.0mm

Nozzle Design for Polyketone

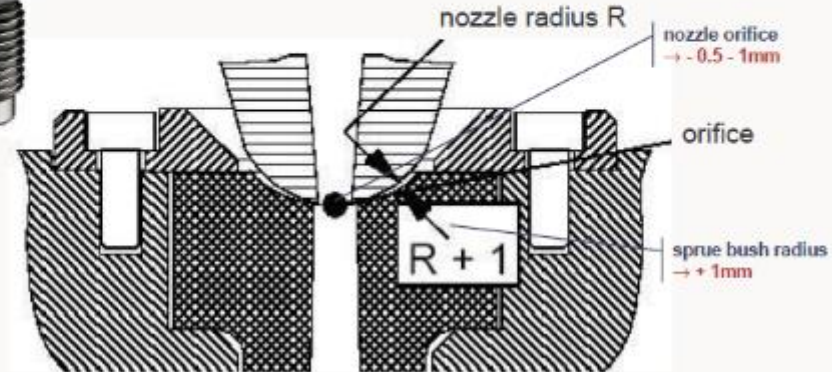


Full Band Coverage and Good Thermocouple Placement is a MUST!

- Well-controlled heated nozzle as using enough capacity heater and separated thermocouple are strongly recommended to prevent freeze-off issue at nozzle due to small sized nozzle orifice or rapid solidification of POK.
- Should be thoroughly purged at processing temperature with purging material such as PCTG, HDPE, GPPS or other commercially available purging compounds.

Nozzle design

Radius and orifice diameter



radius and orifice:

- nozzle < sprue bush
- 0.5 till 1 mm (not too much)

To improve nozzle freeze off issue :

- ✓ Enough nozzle heat capacity and Right thermocouple placement
- ✓ Set only nozzle temp. higher of 5~10 °C than barrel front zone
- ✓ Increase **nozzle orifice** as below;
 - Small m/c(below 200T): min. Ø3.5mm
 - Middle size (200~450T): min. Ø4.0mm
 - Middle to big size(over 500T): min. Ø5.0mm
 - Over 550T : min. Ø6.0mm

Shut-down Procedure for POKETONE

- At the completion of the molding run at normal barrel temperature (about 230~240°C), all traces of POKETONE should be thoroughly purged at processing temperature from the barrel with purging material such as **PCTG, high viscosity-PP, HDPE, GPPS** or other commercially available purging compound. (Should be immediately purged after PK molding)
- After the purge appears clean, the screw is left in the forward position. Barrel and nozzle heats can then be turned off.
- ❖ (Can be purged several times at higher barrel temperature of 270~300°C for better cleaning of POKETONE, then purge again at the normal barrel temperature (about 240 °C) till purging clears.)

Guide Line for downtime during injection molding

✧ Stop within 20 minutes :

1. Stop molding process while maintaining cylinder and Hot runner temp.
2. Purge out several times before re-started molding

✧ Stop from 20 minutes within 2 hours :

1. Purge out all the rest of Poketone material inside cylinder and hot runner manifold
2. Decrease the temperature from current temperature to 20~40°C on cylinder(hot runner temp) and stop molding process while turning on heater.
3. When re-started operation, please increase the temperature to the norm and purge out several times when reach to the temperature

✧ Stop from 2 hours within 12 hours :

1. Purge out all the rest of Poketone material inside cylinder and hot runner and decrease the temperature to 170~180°C on cylinder(hot runner temp) then stop molding process while turning on heater.
2. When re-started operation, please increase the temperature to the norm and purge out several times when reach to the temperature(when increase the temperature, firstly increase cylinder temperature then later increase hot runner temperature)

✧ Stop more than 12 hours :

1. Purge out all the rest of Poketone material inside cylinder and hot runner manifold
2. By using purging material(PCTG, High-density PP, HDPE, GPPS, etc), keep purging out until inside of cylinder is completely cleaned then stop molding operation

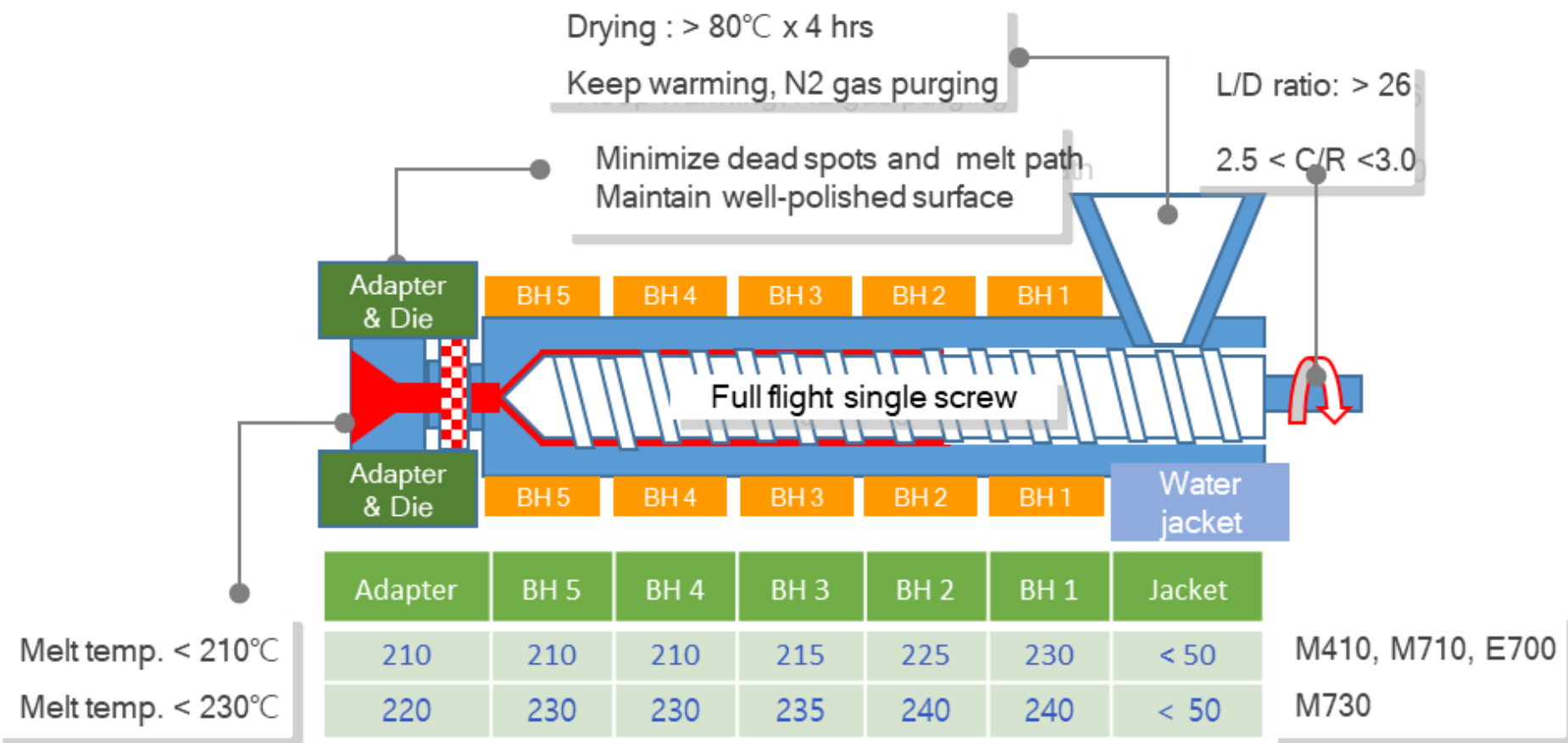
❖ For better cleaning :

1. After purging enough using purging material, increase barrel temp. 30 °C more (to about 270~300 °C) then purge again several times using purging material.
2. Decrease barrel temp to normal, then purge again.

Process Guide

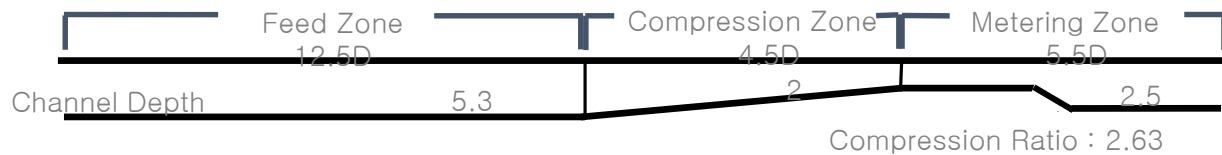
(Extrusion)

Processing conditions for M410, M710, E700, M730



Screw

Compression	Feeding zone	Compression zone	Metering zone
Ratio 2.63:1	45%	30%	25%, 2-stage



- Length-to-diameter(L/D) Ratio: >26
- Compression Ratio(C/R): $2.5 < C/R < 3.0$
- Screw Diameter: $>50\text{mm}\Phi$
- Flight Pitch: 1D (Helix Angle 17.66°)
- Flight Width: 0.1D
- Channel Depth in Feed Section: $0.15 \sim 0.20D$

Barrier transition or Mixing section that can cause deposition is **not recommendable**

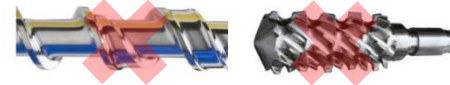


Figure A typical screw for polyketone extrusion

Tube & Pipe Die

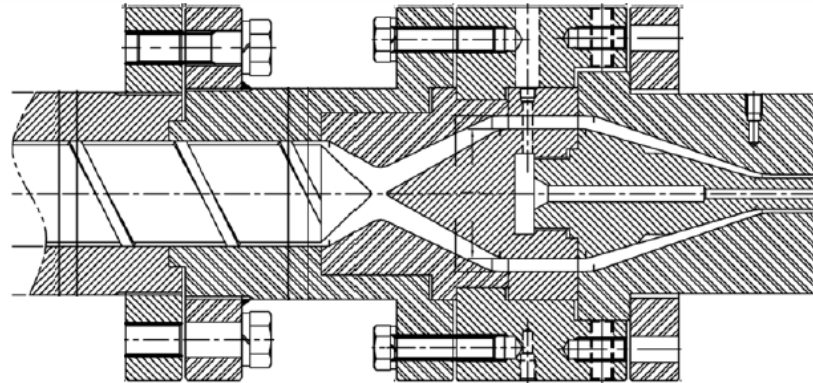


Figure 2. A typical die for polyketone extrusion

- The die should be designed such that the melt has a gradual increase in linear velocity, ensuring a self-cleaning action.
- The area between screw tip and torpedo bottom should be streamlined, thus avoiding low shear rate areas and consequent build-up of stagnant material.
- Basket-type die head is not recommendable. It can cause deposits.

Processing

Process		Recommended condition
Pellet Drying	Method	Dry clean air drying, or vacuum drying
	Temperature	70°C (160°F) and below for dry air drying
	Time	Minimum: 4 hours, maximum: 8 hours
	Conveying	Reduce the contact with ambient air and keep warming
Nitrogen Purging		Recommended at the feed section to reduce the thermal oxidation reaction during extrusion.
Start-Up	Initial Heating	Two steps of heating is recommended. Set the temperature to 150°C in order to avoid the oxidation and degradation of any residue inside the extruder. Move to the 2nd step heating to an initial temperature program before 1 or 2 hours of running the machine. Start the extruder operation using LDPE with a MFR of 2–5. When the extrudate gets clean and stable, drain out LDPE from a hopper and directly pour Polyketone pellets into hopper. Recommend to keep the screw rotation over 30 rpm to avoid a feed bridging problem. When the extrusion gets stable, check the melt temperature (M710: 210°C) and try to lower it step by step as much as possible

Processing

Process		Recommended condition
Purge	Case	When the following phenomena occur, the purging operation is recommended. ▷ Cross-linked gels and black specks are rapidly increased ▷ The color of the products is getting yellowish ▷ The extrudate is rapidly decreasing due to bad feed of the pellets ▷ The melt pressure or the screw torque is abnormally increasing
Purge	Procedure	First of all, follow the standard purge procedure you have. And then refer to the following; 1. Drain or pour the polyketone pellets out and put LDPE with MFR of 2~5 into the hopper or the feed throat 2. Keep the same temperature profile. 3. Continue purging with LDPE until polyketone is completely flushed out. 4. When most of defects disappear in the LDPE melt, directly change over polyketone pellets over LDPE pellet in the feed throat or in the bottom of hopper.
Shut-down	Procedure	First of all, follow the standard shut-down procedure you have. And then refer to the following; 1. Drain or pour the polyketone pellets out and put LDPE with MFR of 0.5~1 into the hopper or the feed throat 2. Keep the same temperature profile. 3. Continue purging with LDPE until polyketone is completely flushed out. 4. When most defects disappear in the LDPE melt, the operation of extruder should be stopped when the extruder is filled with LDPE.