



HYOSUNG CHEMICAL

POKETONE In Brain Protection System on Sports Helmet

Global Warming Potential

* PA6	6.70	
* PA66	6.40	
* PC	3.40	
* POM	3.20	
* ABS	3.10	
** PK	3.08	(kg CO ₂ eq)

* Other ETP data is based upon the Eco-profiles data from www.plasticseurope.org

** PK Data is based upon Korea LCI database and Ecoinvent database.



Non Toxic High Efficiency

Acrylate Free
Melamine Free
Bisphenol A Free
Formaldehyde Free
Lead/ Chrome/ Free
Phthalate Free

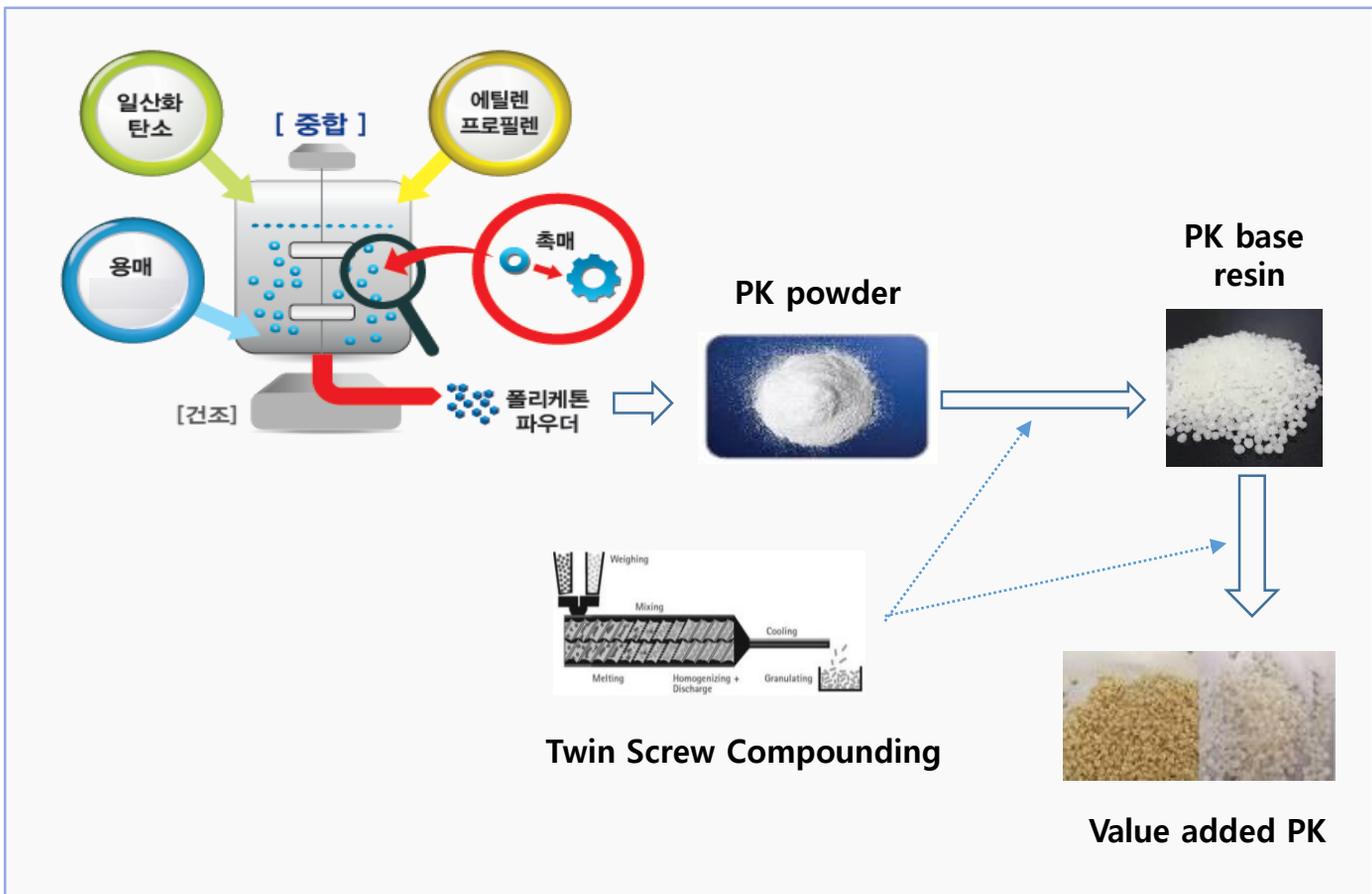
POKETONETM
HYOSUNG POLYKETONE

Further Information
www.poketone.com

1. Introduction – Production of PK pellet

Polymerized PK resin has the form of powder. PK base resin pellet is made through twin screw compounding using optimized process conditions.

For value adding such as wear resistant, filler reinforcing, flame retardant an additional compounding process is applied at the PK base resin with an appropriate additives/fillers under optimized process conditions

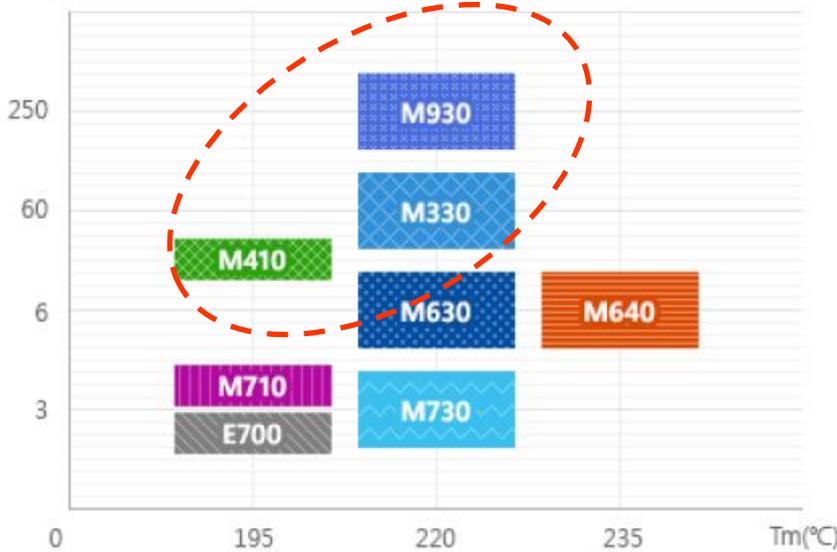


Basically POKETONE is provided as four major colors: NP, BK, GY, WH. But we support RED, BLUE, YELLOW, GREEN and ORANGE coloring according to customer's requirements.

1. Introduction – Base and Compound Portfolio

We have 7 PK base resin portfolio. For Brain Protection System on Sports Helmet, we recommend medium & high flow PK M930, M330 and M410.

MI (g/10min)



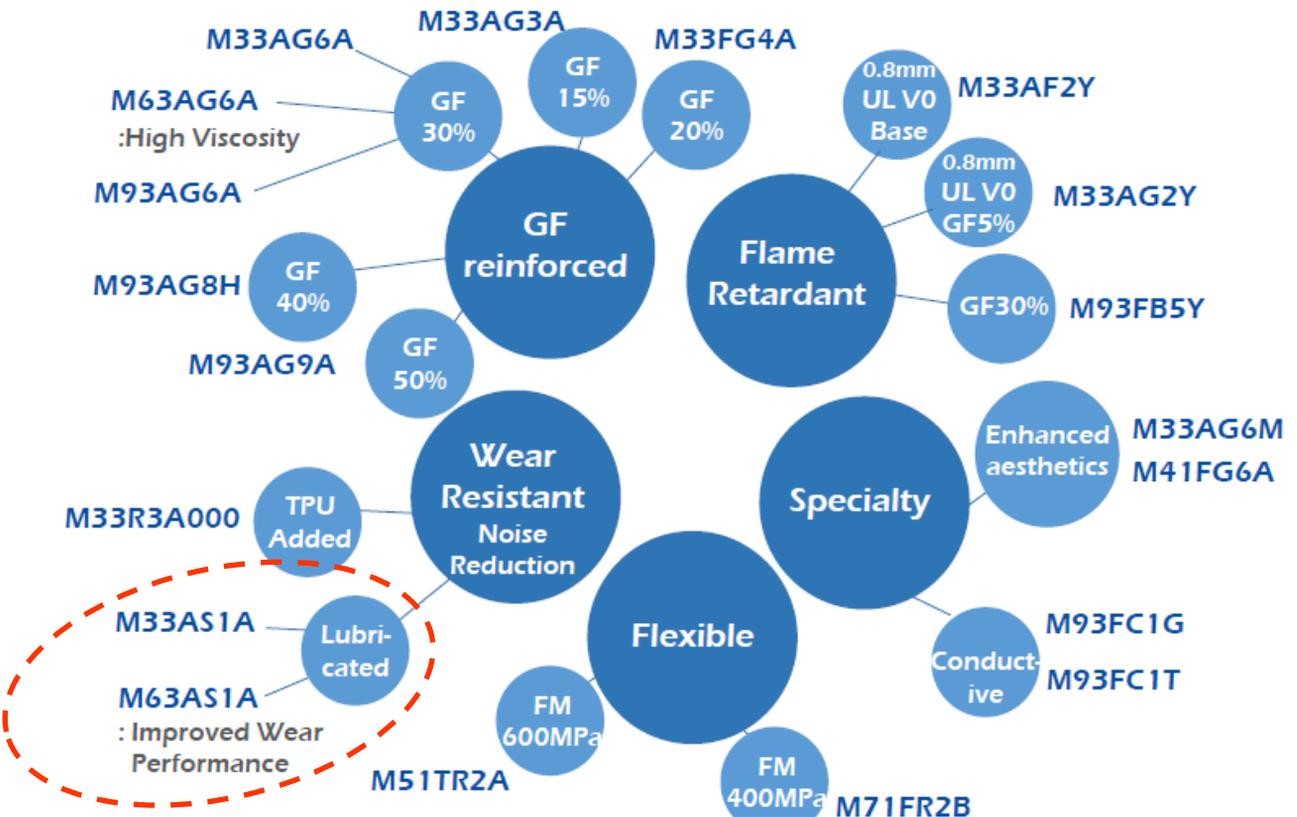
Main Product

- M930 Advanced High Flow
- M330 High Flow
- M630 General Purpose, High Impact
- M730 Low Flow
- M710 Low Flow, Low Tm
- M410 Monofilament, Low Tm

Special product

- E700 PK Compound for EVOH Blend, Resistance to retort treatment
- M640 High Impact at Low temp., High Tm

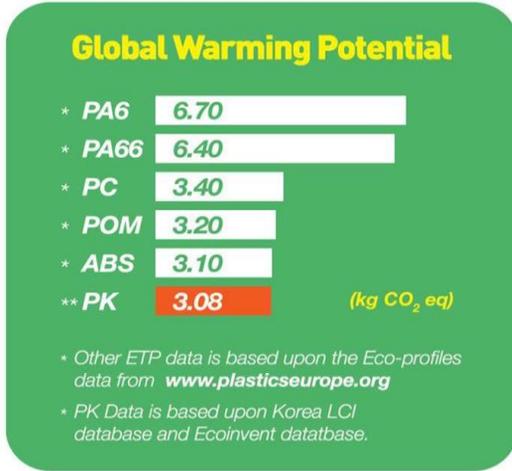
For more wear resistant performances than PK base, we recommend lubricated PK resin



Wear Resistant Compound

2. Eco-Friendliness and Harmlessness of PK Base Resin

HYOSUNG POKETONE has inherently lower CO₂ emission compared with other engineering plastics

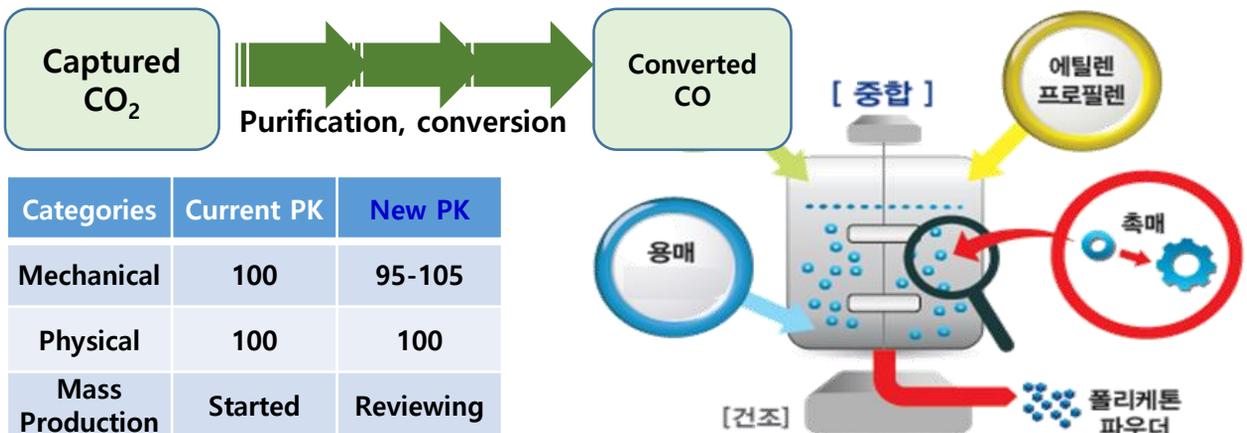


kg CO₂ eq = amount of emitted CO₂ per production of given resin 1kg

HYOSUNG POKETONE has many eco-related and health-related Certificates as NSF, KTW, EU 10/2011, USP 65 and ISO10993.



Hyosung Chemical has a future plan to produce Poketone using recycled CO₂ gas. Named as **NEW PK**, its mechanical & physical properties is verified the same as that for current PK.

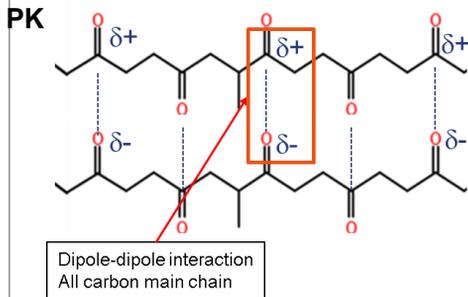


3. Chemical Structure Comparison

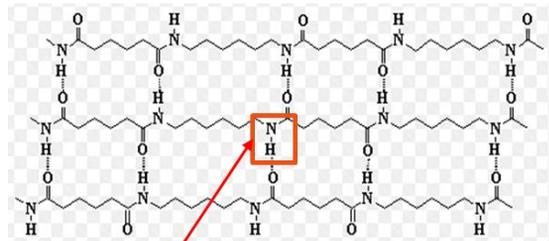
Poketone shows high elongation, impact resistance and good chemical resistances over wide range chemicals compared with other engineering plastics.

It is related to its unique chemical structures: all carbon main chain + dipole interaction

	POKETONE	Other Engineering Plastics
Main chain	All Carbon atom	O, N is periodically inserted
Secondary bonding	Dipole-dipole moment	PA: hydrogen bonding PBT, POM: Van Der Waals
Characteristics	High elongation & impact Generally good chemical resistance	High stiffness Vulnerable to humidity and several chemicals (humidity, steam, CaCl ₂ , chloramine etc)

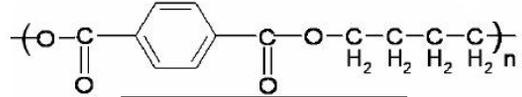


PA



Hydrogen bond
Carbon-Nitrogen main chain

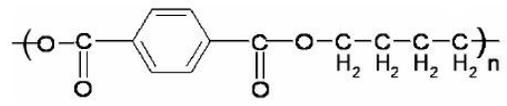
Greatly absorbs humidity
Weak at CaCl₂



PBT

Van Der Waals forces
-COO- main chain

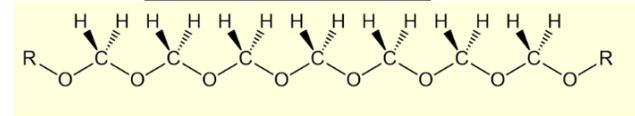
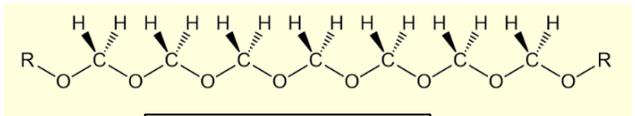
Hydrolysis can occur
at steam exposure



POM

Van Der Waals forces
-C-O- main chain

Weak at chloramine
(Br+Cl detergent)



3. Chemical Resistance: PK vs. other Engineering Plastics

PK is the only engineering plastic with all carbon main-chained back-bone . It gives generally good chemical resistances compared with other engineering plastics which contain O, N atoms in their back bone.

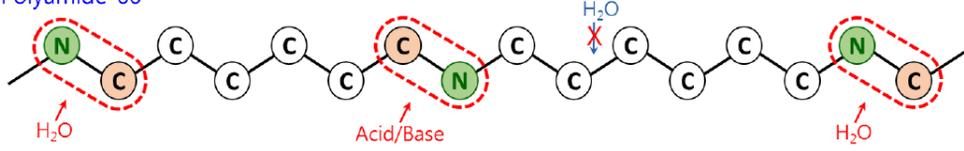
C
Chemical Resistance

against POM

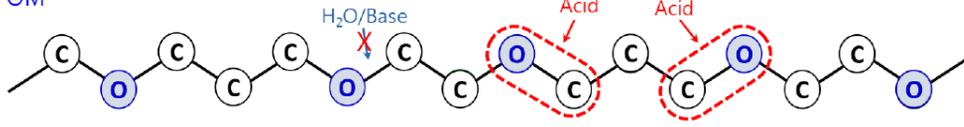
against PA

- PA : Amide Group (-NH-CO-) is weak to Water/Acid/Alkaline
- POM : Ester (R-O-R') group is degraded by acid
- PK : Main Chain is composed with only C-C, so stable to Water/Acid/Alkaline

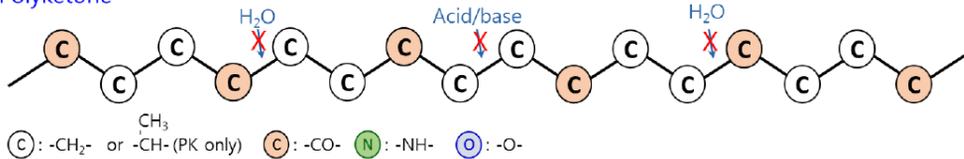
Polyamide 66



POM



Polyketone



	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	●	●	●	○	●	●	●	●	●	●

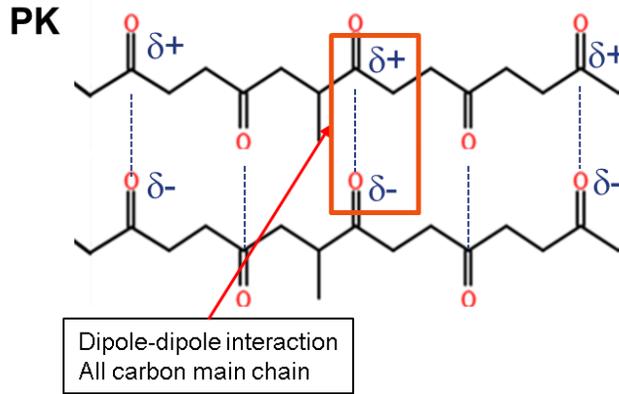
○ : Resistant

● : Not Resistant

3. Key Mechanical Properties Comparison: PK vs. other Enpla.

PK's secondary bonding is dipole-dipole interaction. This gives balanced mechanical properties between stiffness and toughness.

Compared with other engineering plastics, PK's position lies in toughness orientated properties.



Items	Unit	PK M330	PA6	PA66	PBT	POM
Density	g/cm ³	1.24	1.14	1.14	1.30	1.41
Melting Point	°C	222	220	260	220	160
Notched Charpy	kJ/m ²	9.0	5.2	4.6	5.0	6.5
Tensile Strength	MPa	60	80	80	55	65
Elongation at Break	%	>250	<100	<80	16	35
Flexural Modulus	MPa	1,550	2,600	2,900	2,400	2,500

Density



Heat distortion resistance(HDT)



Tensile Strength(Yield)



Toughness



Elongation(Yield)



Hardness



Flexibility



Young's Modulus



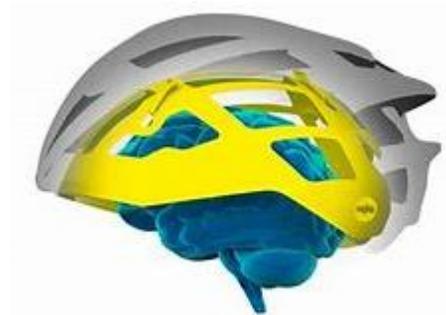
4. PK Portfolio for Brain Protection System on Sports Helmet

Hyosung POKETONE provides 3 neat and 1 wear resistant grades for Brain Protection System on Sports Helmet.

By balancing both wear resistance and impact resistance, Poketone grades give best performances in protecting human brain against external impact with eco-friendliness and human life sustainability.

For further UV protection, we also support order made UV and wear resistant formulation.

Category			Neat resin			Wear Resistant compound
Grade name			M930F	M330F	M410FS	M33AS1A
Physical Properties	Test Method	Unit				
Density	ASTM D792	g/cm ³	1.24	1.24	1.22	1.24
Mechanical Properties	Test Method	Unit				
Tensile Strength	ISO 527	MPa	63	60	45	60
Elongation at Break	ISO 527	%	100	250	300	200
Flexural Strength	ISO 178	MPa	61	57	45	56
Flexural Modulus	ISO 178	MPa	1450	1400	1100	1400
Notched Charpy	ISO 179e1	kJ/m ²	5	8	7	9
Thermal Properties	Test Method	Unit				
Melting Temperature	ASTM D3418	°C	222	222	197	222
MFR 240°C, 2.16kg	ASTM D1238	g/10min	200	60	35	49





· Excellent Wear Resistance · Low Noise · Low abrasion loss (no particle) · Excellent chemical resistance

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