

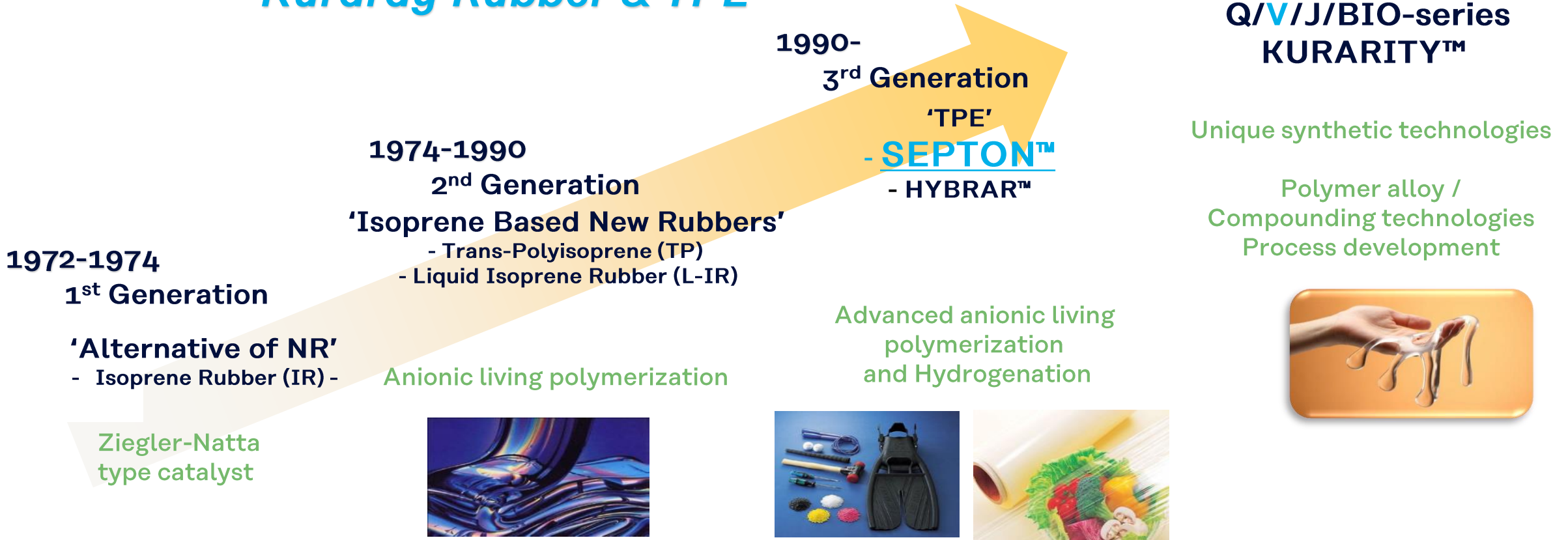
# Introduction of SEPTON™ V-series

Elastomer R&D department  
Elastomer division

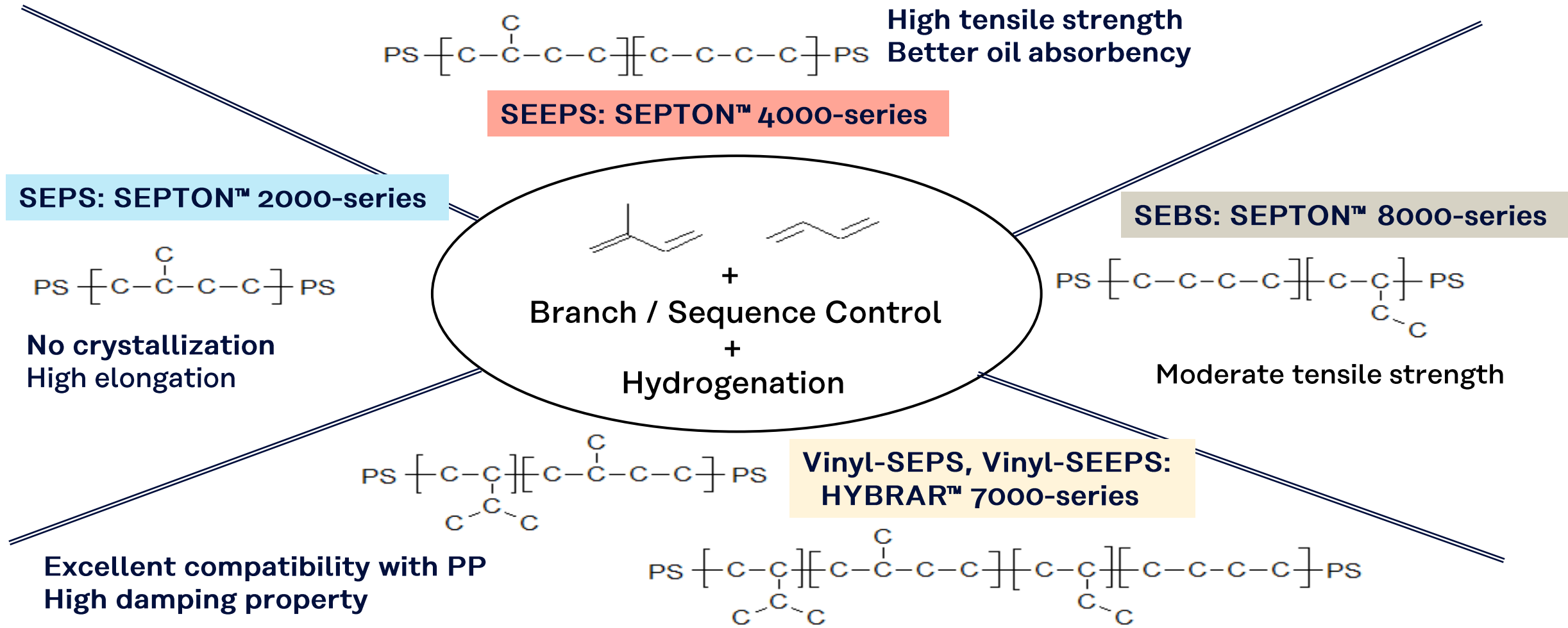
***kuraray***

# Kuraray Elastomer History

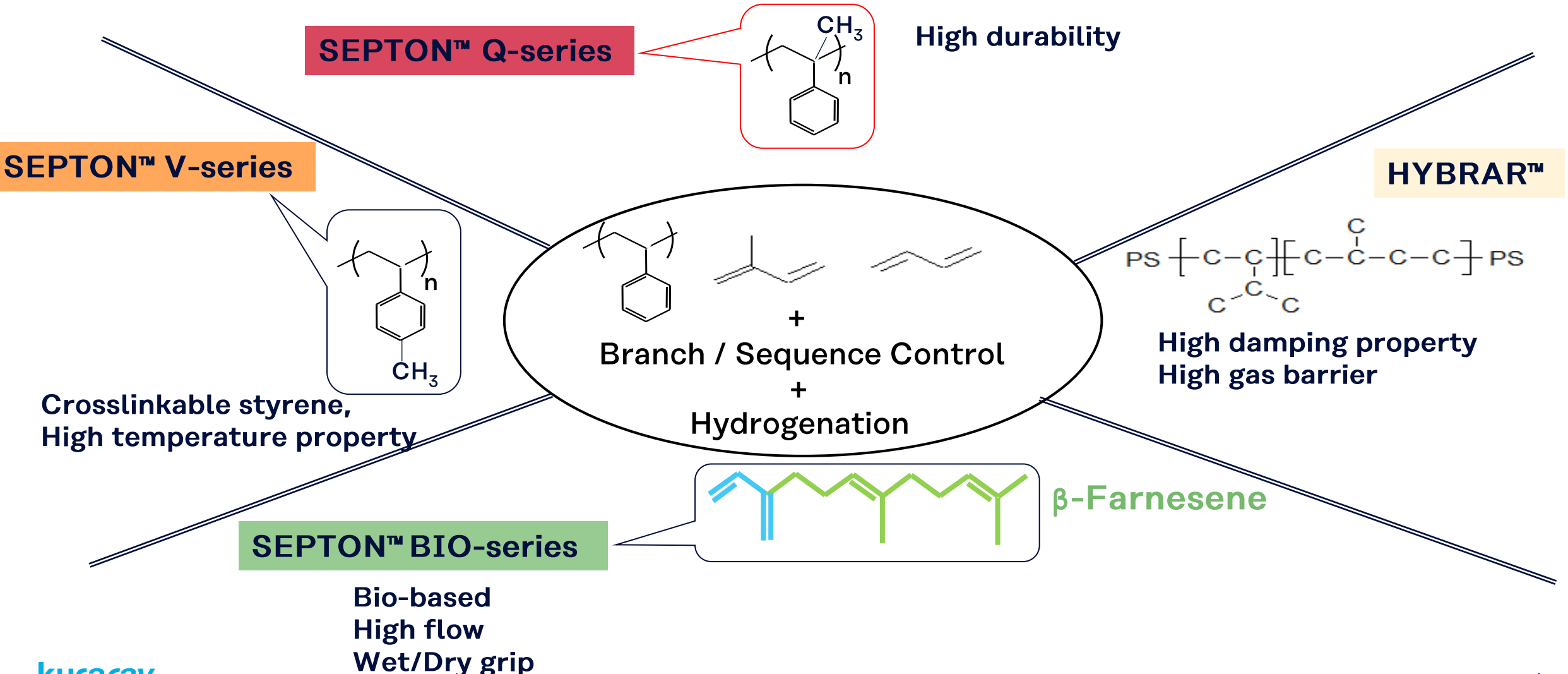
## Achievement of continuous innovation of Kuraray Rubber & TPE



# Polymer Structure and Kuraray's Product Lineup



# Polymer Structure and Kuraray's Product Lineup



# What is SEPTON™ V-series ?

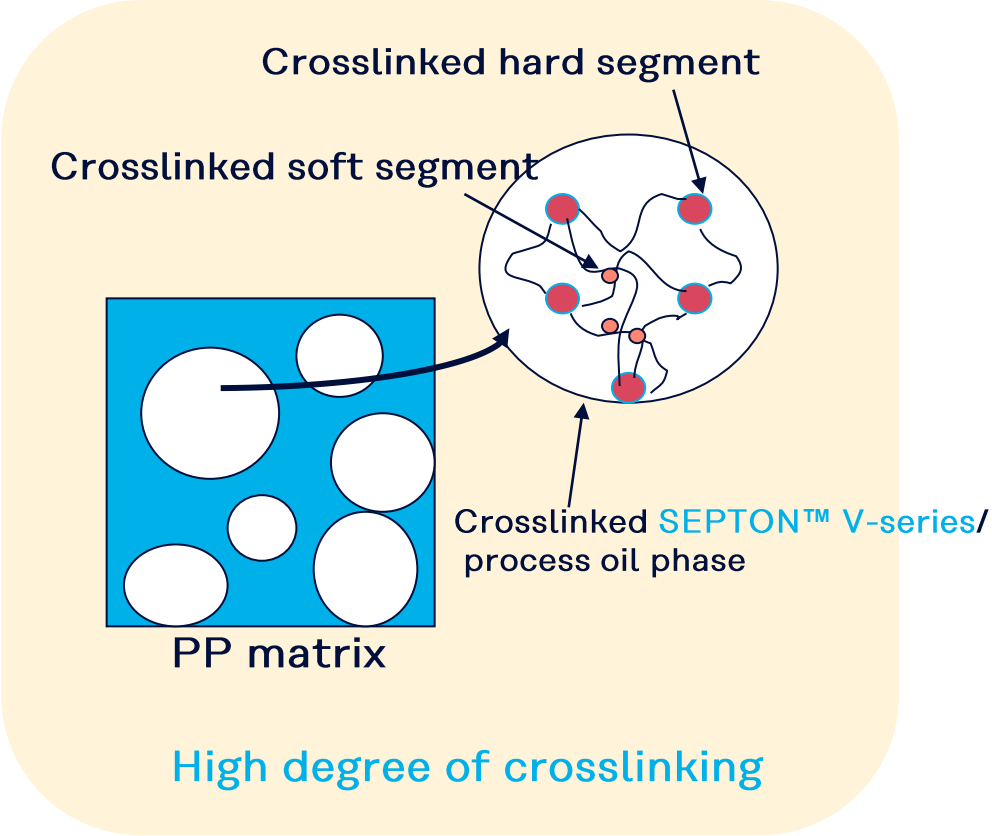
- SEPTON™ V-series
  - Styrenic Block Copolymer for Thermoplastic Vulcanizates (TPV)
  - Crosslinkable soft block and hard block
  - Generally, all ingredients are mixed and run as one batch through the hopper - no downstream injection, stuffing, etc.
  - No corrosion of equipment

# SEPTON™ V-series Grades

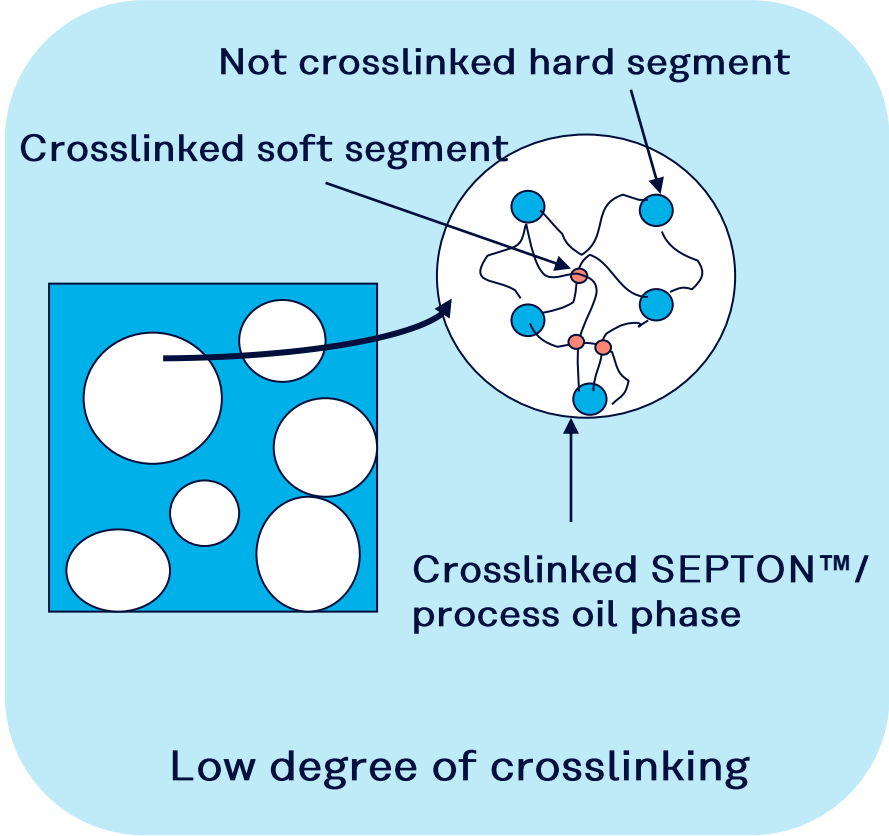
Grade	Type	Hard block content (wt%)	Specific gravity	MFR (230 deg.C, 2.16 kg, g/10 min)	Solution viscosity (5 wt%, mPa·s)	Physical Form
V9461	SEEPS	30	0.89	No flow	90	Powder
Measurement method			ISO 1183	ISO 1133	Toluene solution 30 deg.C	

# Dynamic Crosslinking

## Dynamic crosslinked SEPTON™ V-series compounds



## Dynamic crosslinked SEPTON™ compounds



# Example Formulations and Properties

		Crosslinked SEPTON™ V-series compound			TPV
SEPTON™ V9461		100	100	100	-
Paraffin oil*1		200	100	100	-
Polypropylene*2		15	27.3	50	-
Organic Peroxide		6	6	6	-
Crosslinking Agent		12	12	12	-
Antioxidant		0.1	0.1	0.1	-
Typical properties					
Hardness (Hs)	Type A	29	60	75	61
Compression set @120 deg.C_22 h	%	21	26	37	27
	@120 deg.C_500 h	-	30	-	50
100% modulus	MPa	0.5	2.3	3.5	1.9
Tensile strength	MPa	2.3	5.9	8.7	3.3
Elongation	%	360	300	340	220
MFR (230 deg.C, 5 kg)	g/10 min	3.7	1.2	57.9	1.5

\*1 Viscosity : 382 mm<sup>2</sup>/s at 40 deg.C, \*2 Homo-PP, MFR=0.5 g/10 min

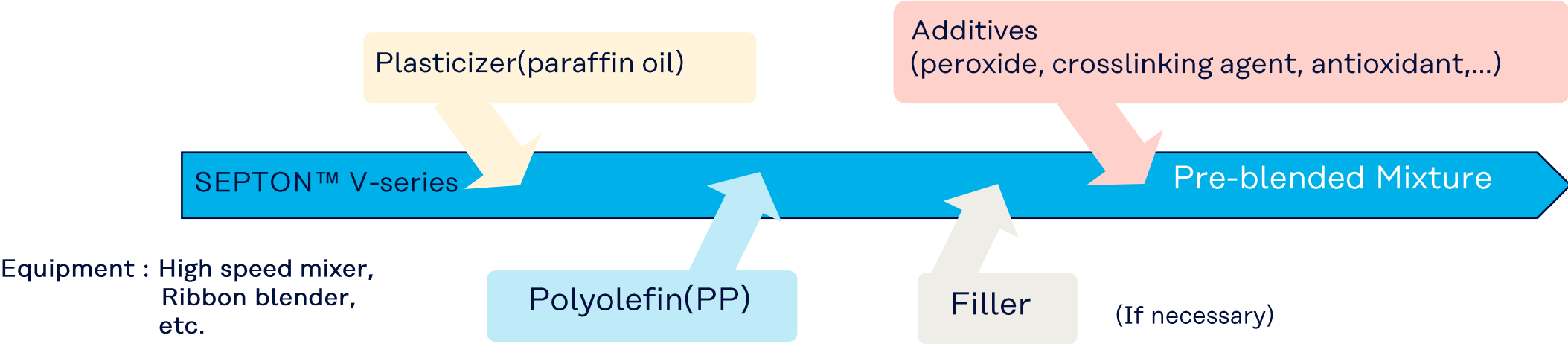


# Pre-blend Procedure for Dynamic Crosslinked SEPTON™ V-series Compounds

High speed mixer



## Pre-blend procedure



Process of pre-blending is important because nonuniformity of pre-blended mixture causes nonuniformity of crosslinking.

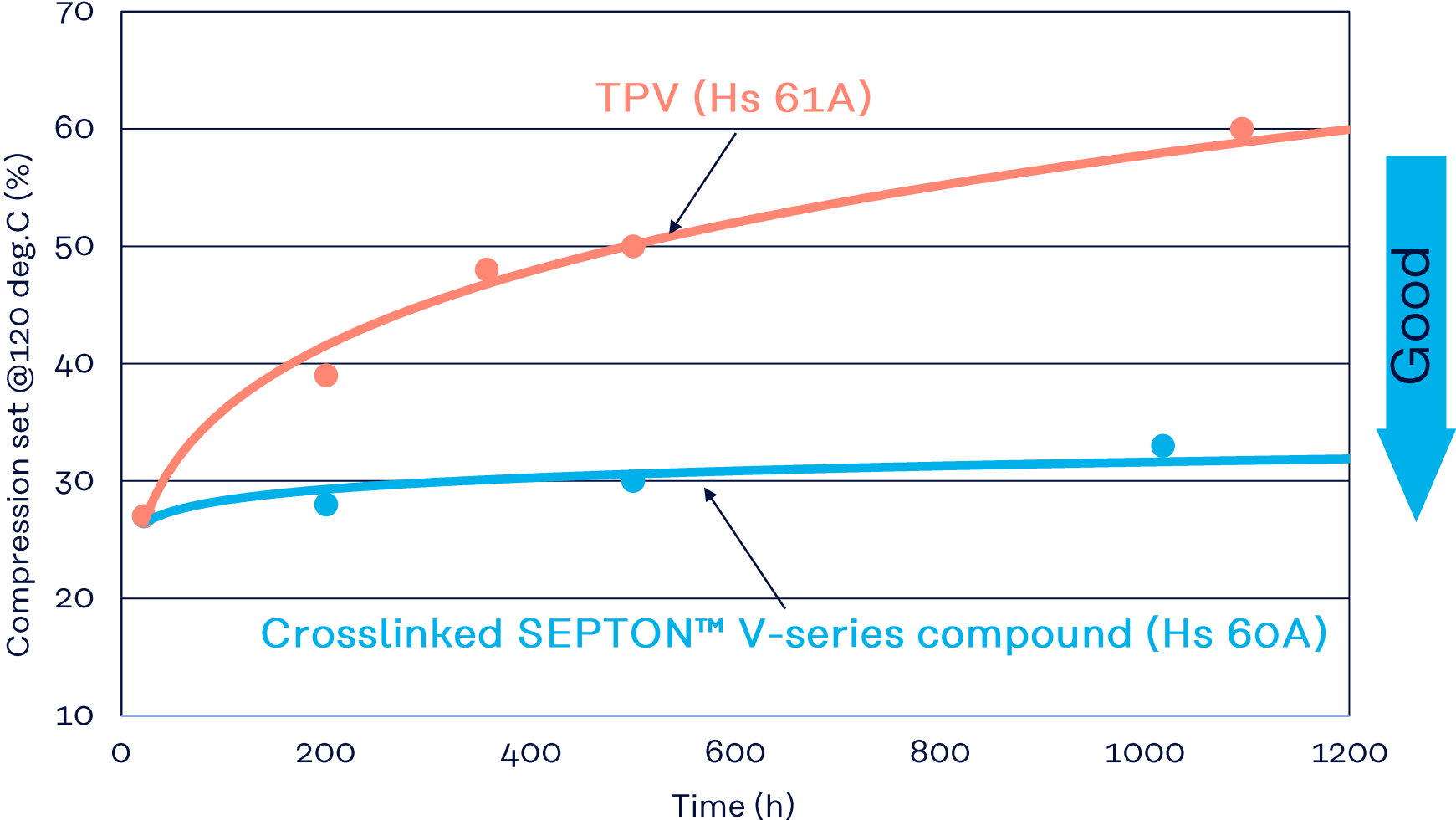
# Mixing Procedure for Dynamic Crosslinked SEPTON™ V-series Compounds

## Kuraray's mixing conditions

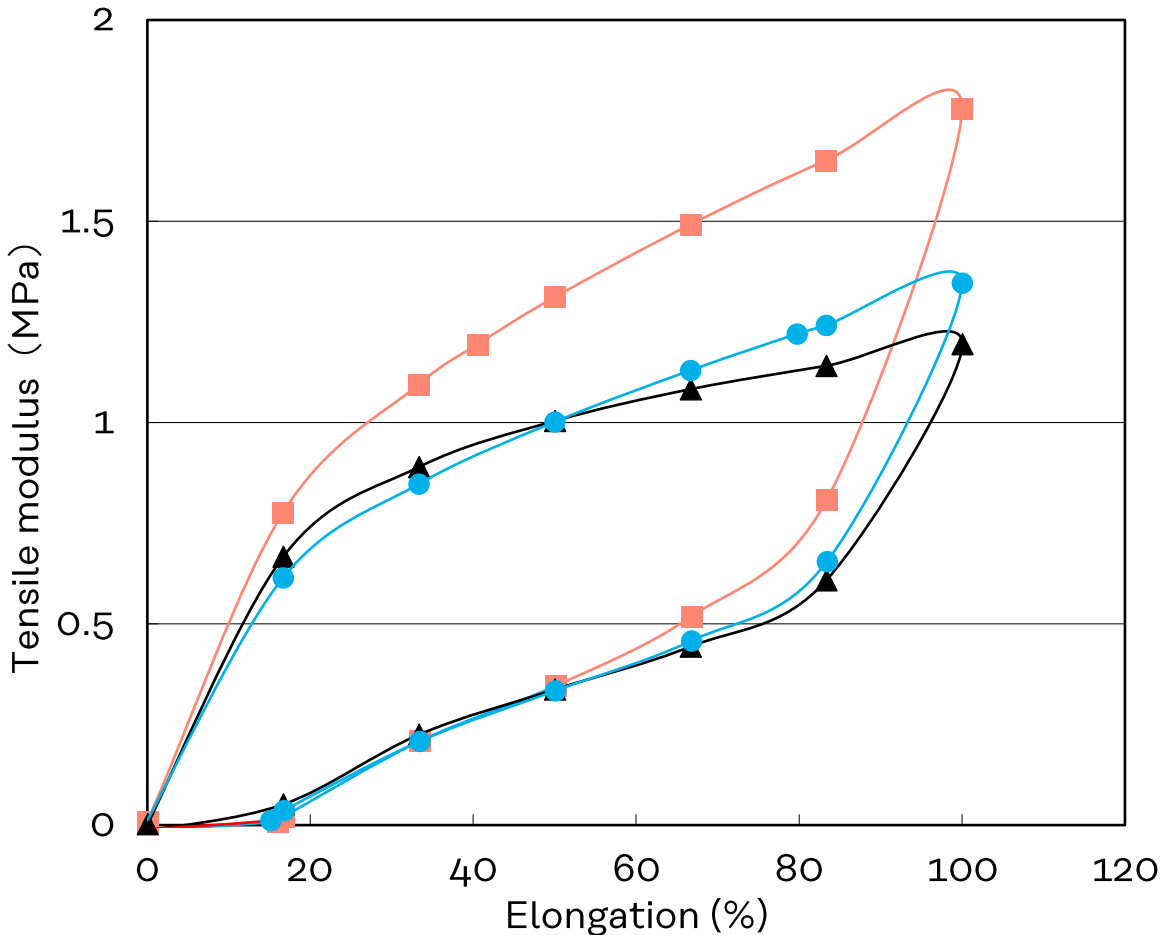
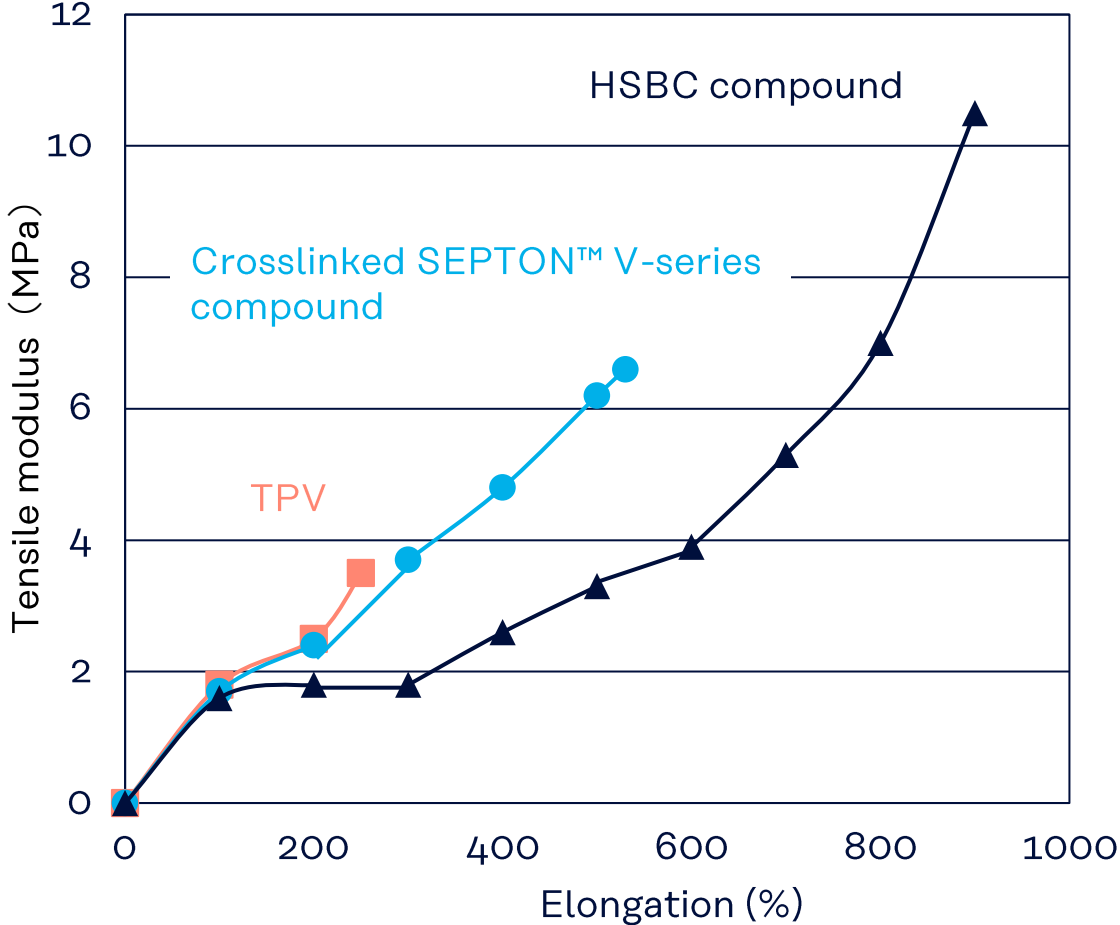
- Equipment:  
TEM 35B Twin Screw Extruder  
(Shibaura Machine Co., Ltd.)  
Diameter of Screw: 37 mm, L/D=34 mm/mm
- Barrel Temperature
  - C1—C3 160-170 deg.C
  - C4—C5 190-200 deg.C
  - Die head 190-200 deg.C
- Rotation of Screw : 200 rpm



# Long-term Compression Set Property



# Rubber Elasticity



# Coloring

Natural



HSBC  
compound

Crosslinked  
SEPTON™ V-series  
compound

TPV

Sky blue



HSBC  
compound

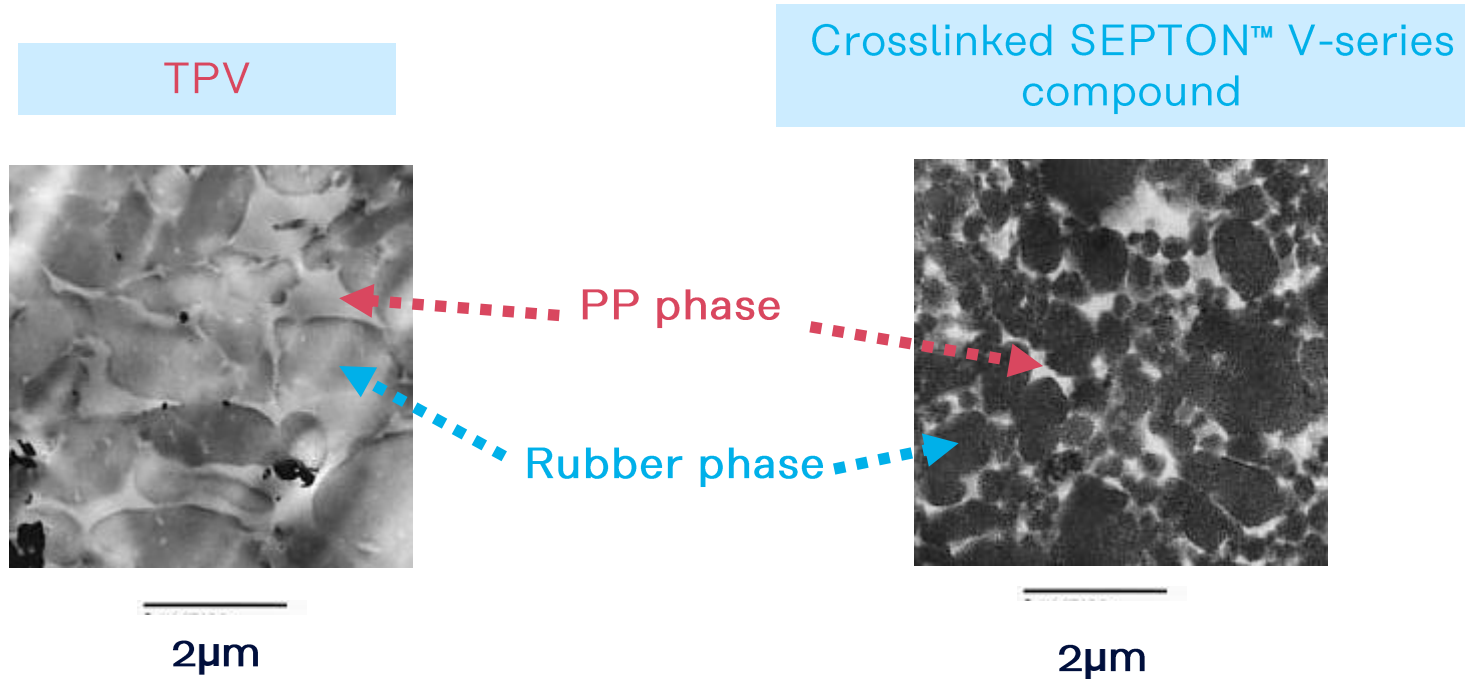
Crosslinked  
SEPTON™ V-series  
compound

TPV

# Typical Properties

	Crosslinked SEPTON™ V-series compound	TPV	HSBC compound (Non-crosslinked)
Compression set	Good	Good	Poor
Long-term compression set	Excellent	Poor	Poor
Rubber elasticity	Good	Poor	Excellent
Tear strength	Good	Poor	Excellent
Coloring	Good	Poor	Excellent
Oil resistance	Good	Good	Poor
Moldability (injection)	Good	Good	Good
Moldability (extrusion)	Good	Good	Good
Molding cost	Good	Good	Good
Recyclability	Good	Good	Good

# Morphology

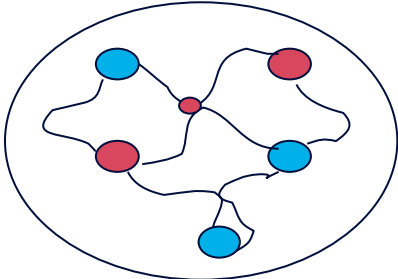


- ✓ Rubber phases are more finely dispersed in crosslinked SEPTON™ V-series compound than TPV.
- ✓ As compressed stress is dispersed to each rubber phase homogeneously, crosslinked SEPTON™ V-series compound is restored well after stress release.

# Crosslinking Effect on Dynamic Crosslinked SEPTON™ V-series Compounds Properties

## Low degree of crosslinking

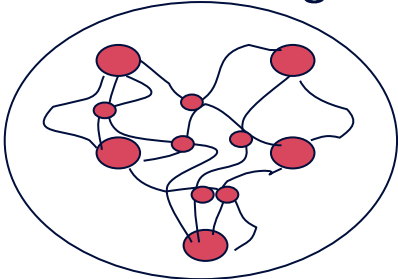
Very small amount of crosslinking agent and co-agent



Compression set **Poor**  
 Oil resistance **Poor**  
 Tear strength **Excellent**

## High degree of crosslinking

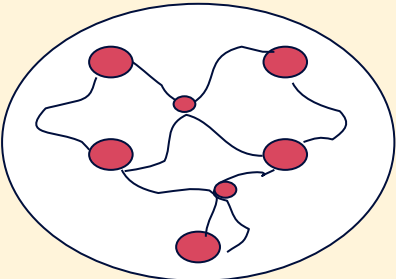
Large amount of crosslinking agent and co-agent



Compression set **Excellent**  
 Oil resistance **Excellent**  
 Tear strength **Poor**

## Moderate degree of crosslinking

- Small amount of crosslinking agent and co-agent
- Selective crosslinking of hard segment



Compression set **Excellent**  
 Oil resistance **Good**  
 Tear strength **Good**



# Advantages and Potential Application of Dynamic Crosslinked SEPTON™ V-series Compounds

## Advantage

- Lower compression set over time
- Lower compression set, and higher tensile strength and elongation at same hardness
- No corrosion of equipment

## Potential Application

- Automotive Applications
- Gaskets, Seals, and O-rings
- Adhesives
- Electronic Parts
- Sporting Goods

# Thermoplastic Vulcanizates (TPV) and Dynamic Crosslinked SEPTON™ V-series Compound Blend

Elastomer R&D department  
Elastomer division

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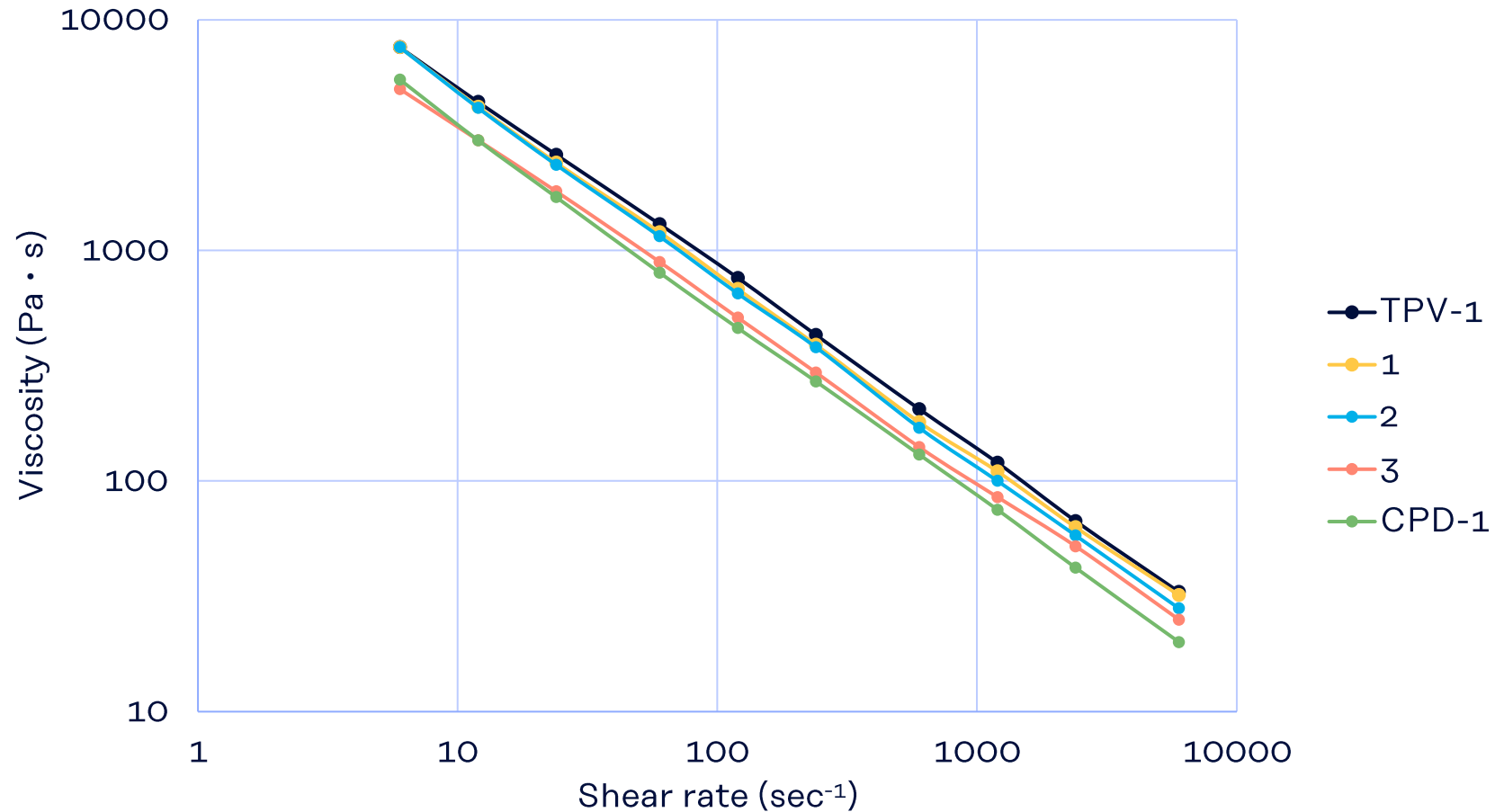
# Formulations & Properties (80A)

No.	TPV-1	1	2	3	CPD-1
TPV-1	100	90	80	60	-
CPD-1* (Dynamic crosslinked SEPTON™ V-series compound)	-	10	20	40	100
Antioxidant (to compound)	-	0.1	0.1	0.1	-
Hardness (Type A)	84	83	83	83	72
Compression Set (70 deg.C, 22 h)	28	32	31	33	36
(120 deg.C, 22 h)	33	34	33	34	34
100% Modulus (MPa)	3.8	3.7	3.7	3.5	2.7
300% Modulus (MPa)	5.9	5.9	6.1	6.0	5.6
Tensile Strength (MPa)	9.6	8.9	9.3	8.7	7.6
Elongation (%)	490	470	470	470	410
Flow length (mm) (injection molding)	190	200	209	225	310

\*SEPTON™ V-series V9461/ Paraffin oil (Viscosity=382 mm<sup>2</sup>/s at 40 deg.C)/Homo-PP(MFR=0.5)/Organic peroxide/ Crosslinking co-agent/Antioxidant (100/100/50/4.6/8/0.3)

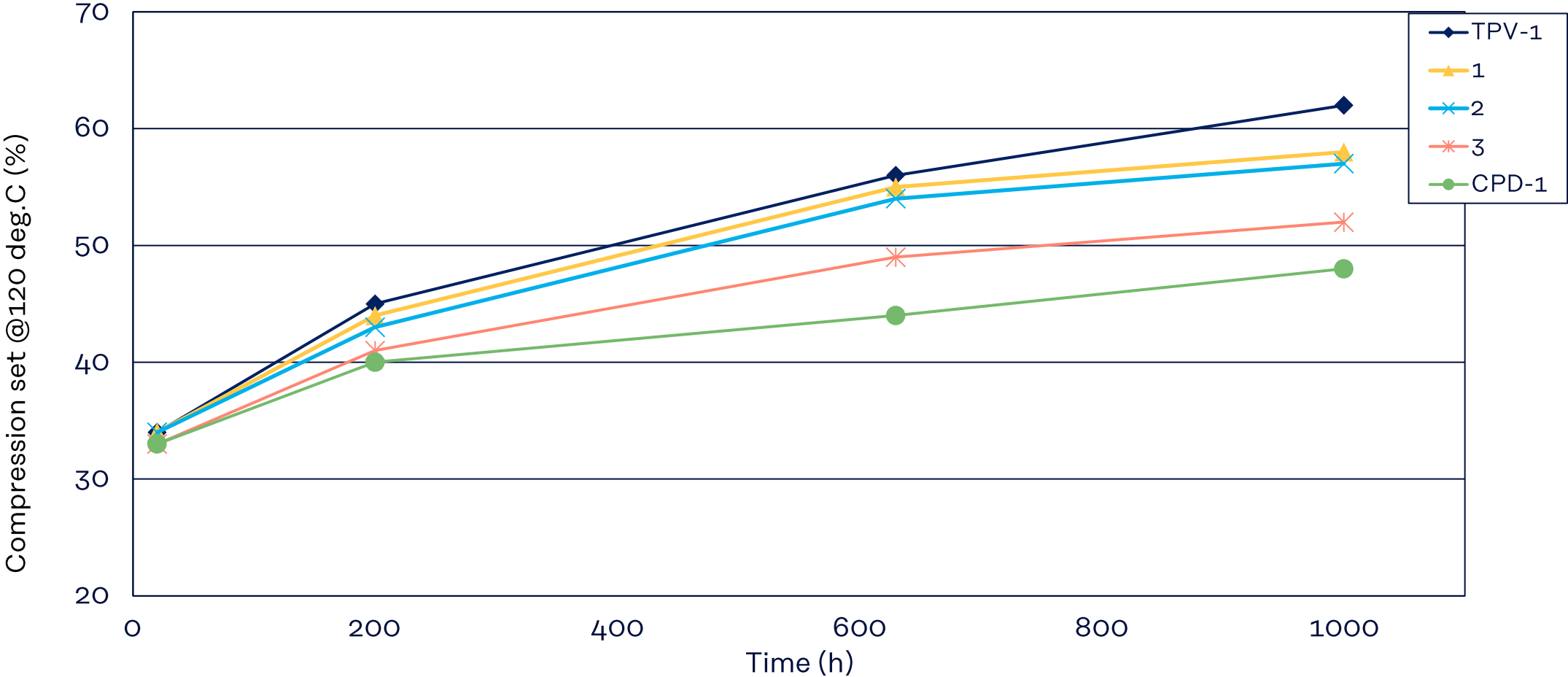
Flow-ability is improved with keeping excellent compression set (120 deg.C).

# Flow-ability (Capillary flow test at 230 deg.C)



Flow-ability is improved with dynamic crosslinked SEPTON™ V-series compound.

# Long-term Compression Set Property



Long-term compression set is improved with dynamic crosslinked SEPTON™ V-series compound.

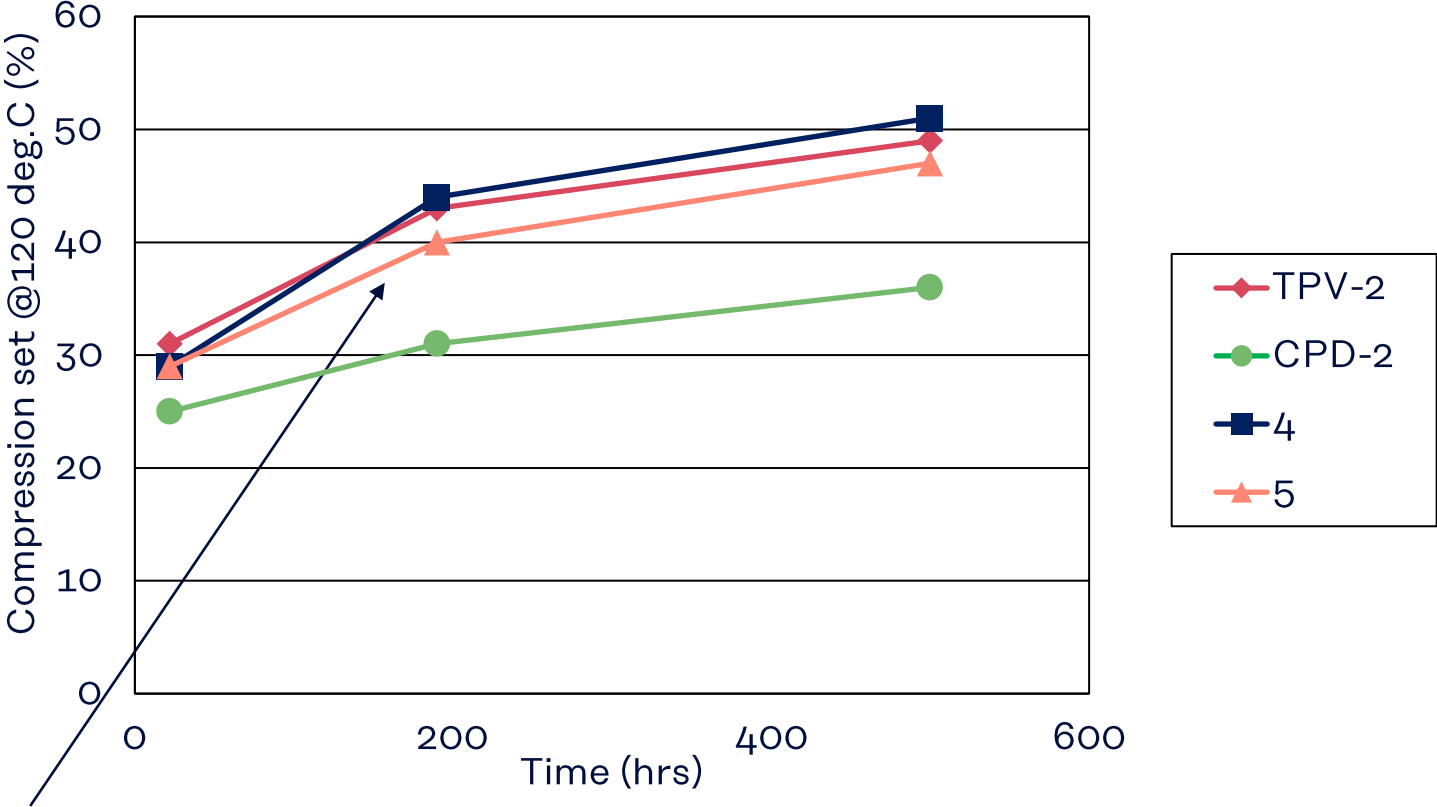
# Formulations & Properties (60A)

No.	TPV-2	4	5	CPD-2
TPV-2	100	80	50	-
CPD-2* (Dynamic crosslinked SEPTON™ V-series compound)	-	20	50	100
Antioxidant (to compound)	-	0.1	0.1	-
Hardness (Type A)	62	63	62	60
Compression Set (120 deg.C, 22 h) [Compression molding]	31	29	29	25
100% Modulus (MPa)	1.9	1.8	1.8	2.3
300% Modulus (MPa)	3.4	3.4	3.7	5.2
Tensile Strength (MPa)	3.5	5.4	5.8	6.7
Elongation (%)	390	420	380	400

\*SEPTON™ V-series V9461/ Paraffin oil(Viscosity=382 mm<sup>2</sup>/s at 40 deg.C)/Homo-PP(MFR=0.5)/Organic peroxide/ Crosslinking co-agent/Antioxidant (100/100/27.3/3.5/6/0.1)

Tensile strength of TPV is improved.

# Long-term Compression Set Property



Long-term compression set of TPV is improved.



More improvement by co-dynamic vulcanization of TPV and SEPTON™ V-series is expected.

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