AsahiKASEI

S.O.E.™

Hydrogenated Styrenic Thermoplastic Elastomer (SEBS)

Contents

1 Fundamentals 2

2 Basic Properties of S.O.E.™ 3-6
1. Tan δ of S1605, S1611, S1606, S1609
2. Solubility in specific solvents
3. Vibration-damping behavior
4. Scratch resistance
5. Anti-abrasion property

3 Use and Effect of S.O.E.™ 7-14
1. Superior shock absorption, in foamed S.O.E.™ cushion
2. Low rebound cross-linked foam
3. Adhesion layer for protective film
4. Formulations with high filler content enabled by S.O.E.™
5. Artificial leather
6. Asphalt modification
7. PPE modification

4 Important Notes and Precautions 15

1 Fundamentals

S.O.E.™ is a hydrogenated styrenic thermoplastic elastomer (SEBS). It is hydrogenated with our original designed styrene butadiene copolymer.
S.O.E.™ is characterized by soft (middle) block structure and it enables S.O.E.™ to have high compatibility with polar resins, high adhesion, vibration reduction property and abrasion resistance.

Salient Features

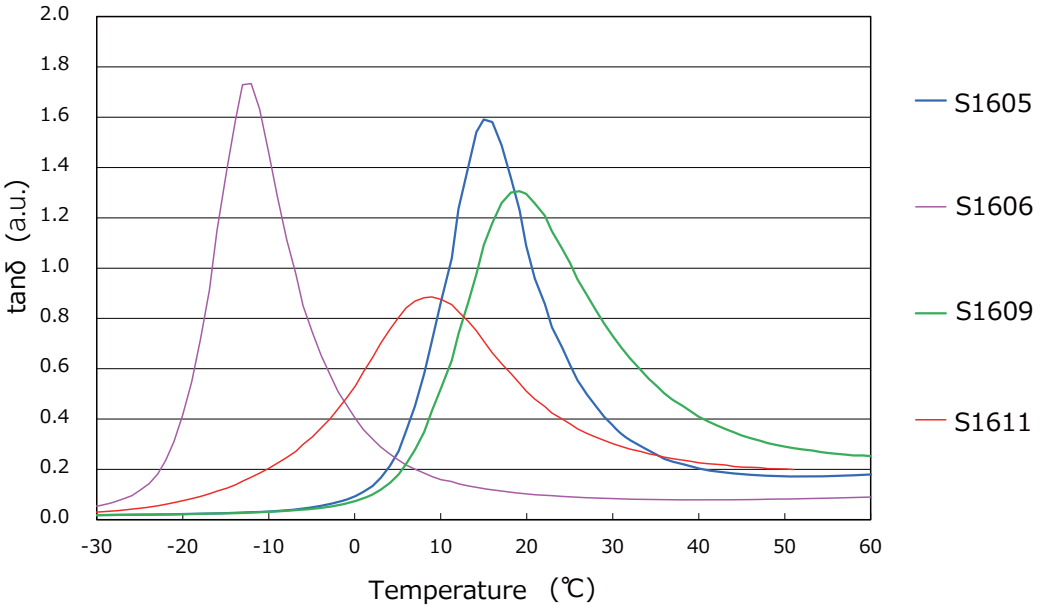
- Good compatibility and adhesion with polar resins due to high solubility parameter
- High acceptability of inorganic fillers
- High damping property and low resilience property around room temperature
- Anti-abrasion property and scratch resistance
- Superior chemical resistance against acids, alkalis and alcohols
- Touch and feel similar to flexible PVC

Grades and Properties

Grade				S1605	S1611	S1606	S1609
Property	Test Method	Test Condition	Unit	Non-oil Extended			
Density	ISO 1183	-	g/cm³	1.00	0.99	0.96	1.00
MFR	ISO 1133	230℃ 2.16 kgf	g/10 min	5.0	12.0	4.0	-
		190℃ 2.16 kgf	g/10 min	-	4.0	0.8	2.5
Hardness	ISO 7619	Durometer Type A	-	87	71	67	87
Tensile Strength	ISO 37	Dumbbell Type 1A 500 mm/min	MPa	32.3	23.0	20.0	26.0
Elongation			%	460	600	490	640
300%Tensile Stress			MPa	12.6	4.0	3.6	4.0
Tg Peak			℃	18	9	-13	19
Rebound Resilience			%	4.0	5.0	65	5.0
Physical Form				Pellet			

2 Basic Properties of S.O.E.™

1 . Tan δ of S1605, S1611, S1606, S1609

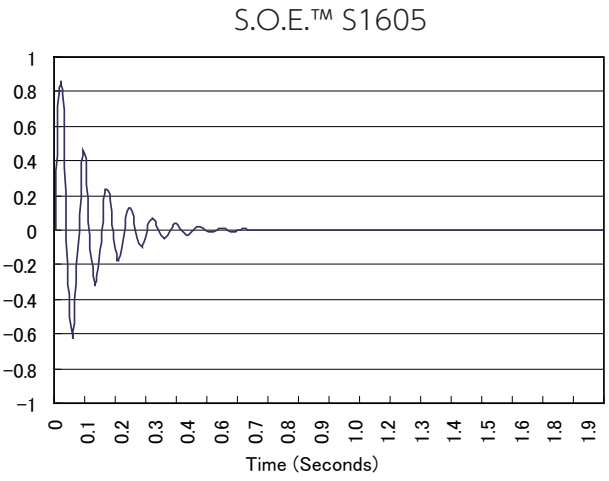


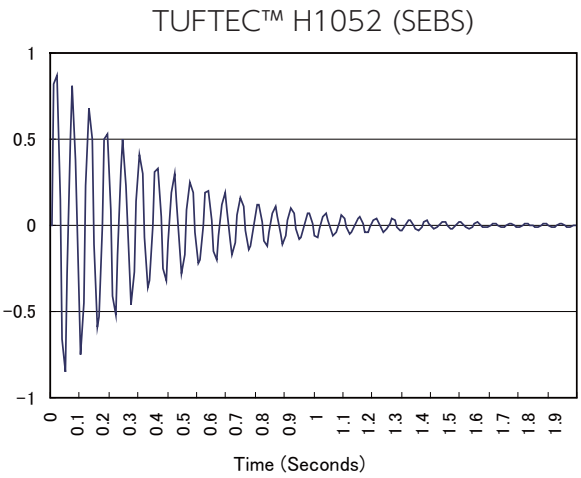
2. Solubility in specific solvents

Soluble
Cyclohexane
Toluene
Xylene
THF
Chloroform

Low or in soluble
Ethanol
Methanol
Isopropanol
n-pentane
n-hexane
Acetone

3. Vibration-damping behavior





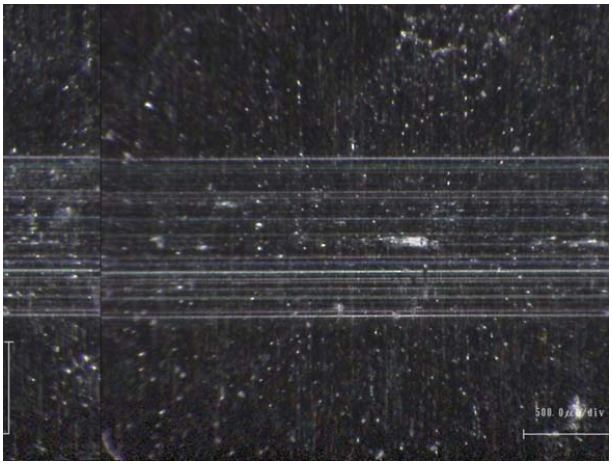
Loss coefficient measurement by cantilever method

Sample grade	Hardness Shore A after 10s	Temp.	1st resonance		2nd resonance	
			Frequency [Hz]	Loss factor	Frequency [Hz]	Loss factor
TUFTEC™ H1052	65°	23℃	15.800	0.052	33.800	0.082
S.O.E.™ S1605	67°	23℃	7.031	0.799	26.938	0.466
	67°	50℃	4.875	0.093	12.719	0.166
S.O.E.™ S1611	54°	23℃	6.969	0.809	22.125	0.442
	54°	50℃	3.938	0.110	10.250	0.218
S.O.E.™ S1609	61°	23℃	7.313	0.779	26.875	0.464
	61°	50℃	5.250	0.113	12.688	0.259

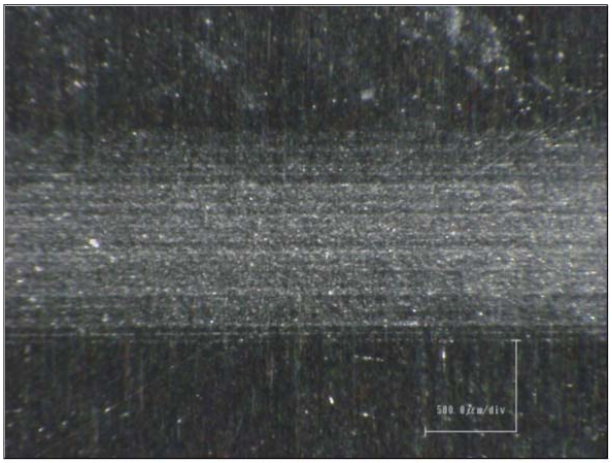
4. Scratch resistance

Similar or better scratch resistance compared to PVC.

S.O.E.™



PVC



Pencil hardness test results

Load: 100 g
Pencil hardness: 9H
Scratch direction: right to left

5. Anti-abrasion property

Similar or better abrasion resistance compared to flexible PVC.

S.O.E.™

Flexible PVC

Surface after 10,000 wearing test cycles

Friction material: Shirting No.3
Load: 500 g
Surface: R shape, width 9.5 mm

Olefinic Thermoplastic Elastomer

After 4,000 wearing test cycles

3 Use and Effect of S.O.E.™

1 . Superior shock absorption, in foamed S.O.E.™ cushion

Can be used for shock absorber of high performance sports shoes with superior shock absorption property.

Formed S.O.E.™ properties

Property	Unit	S.O.E.™	
		Compression	Remolded
Hardness	Asker C	35	33
Resilience	Ball drop % 22℃	7	8
Specific gravity	-	0.164	0.170
Tensile strength	Kgf/cm² MPa	17 1.7	16 1.6
Elongation	%	210	240
Tear strength	Kgf/cm N/cm	5.6 55.0	4.6 45.1
Tear strength (split)	Kgf/cm N/cm	1.0 9.8	1.0 9.8
Compression set	%	48	39

Sports shoes
Shock absorber marked by red oval

2. Low rebound cross-linked foam

Impart low resilience to EVA cross-linked foam by blending S.O.E.™ and EVA.

Composition and properties of EVA / S.O.E.™ blend foam

S.O.E.™		S1605	S1611	S1609
Composition	S.O.E.™ S1605	50	–	–
	S.O.E.™ S1611	–	50	–
	S.O.E.™ S1609	–	–	50
	EVA	50		
	Additive agent (Cross-linking agent, foaming agent, filler))	Approximately 10		
Specific gravity		0.30		
Property	(a) Productivity, Uniform foaming performance	Fair	Good	Good
	(b) Tear strength (N/cm)	100	140	120
	(c) Peel strength (N/cm)	24	31	28
	(d) Peel strength (%) 70℃	35	25	30
	(e) Anti-abrasion property (William abrasion method)	Good	Excellent	Excellent
	(f) Resilience (Ball-drop test)	12%	18%	12%
Feature		–	Resists becoming rigid at low temperature	Excellent low-rebound characteristics

Recommended applications

Automobile, electric appliance, office equipments, audio component, vibration-damping for shoes, insulation, sound absorption.

3. Adhesion layer for protective film

S.O.E.™ is applicable to both inflation molding and co-extruded molding. Control of adhesion to protected material surface is enabled by formulating S.O.E.™ and Tuftec™ in adhesion layer.
S.O.E.™ used protected films do not split off from protected surface during transport and handling, but can be removed cleanly with no adhesive residue on the protected material.

Protected surface and adhesion-layer content

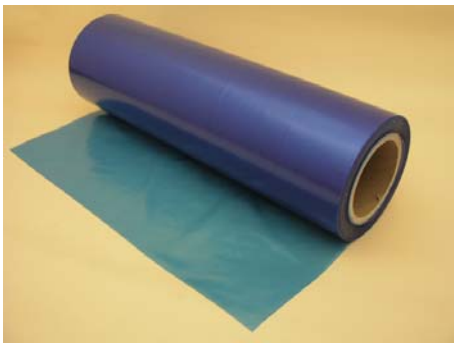
S.O.E.™/Tuftec™ ratio and adhesion-release properties on typical surfaces

Adhesion Layer / Protected Surface	Tuftec™	50%	70%	90%
	S.O.E.™	50%	30%	10%
Metal		G	G	G
Plastic board		F	G	G
Coated plywood board		F	G	G

G: good, F: fair

Film structure

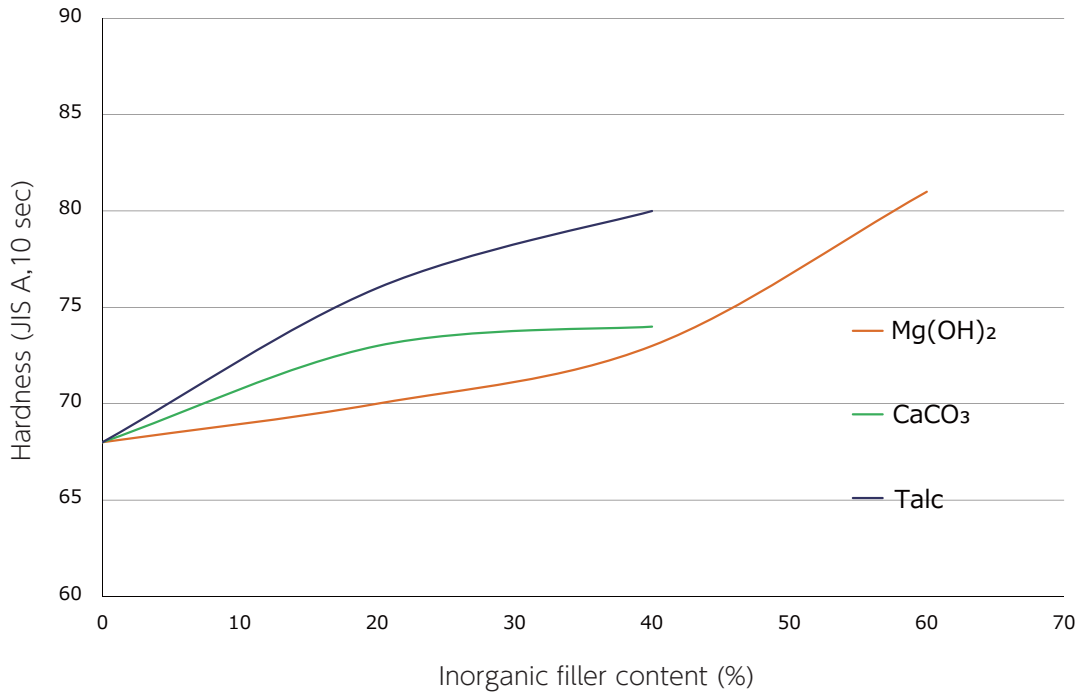
Layer	Composition
Surface	Specialized polyolefin
Core	Polyolefin
Adhesion	Tuftec™ and S.O.E.™



4. Formulations with high filler content enabled by S.O.E.™

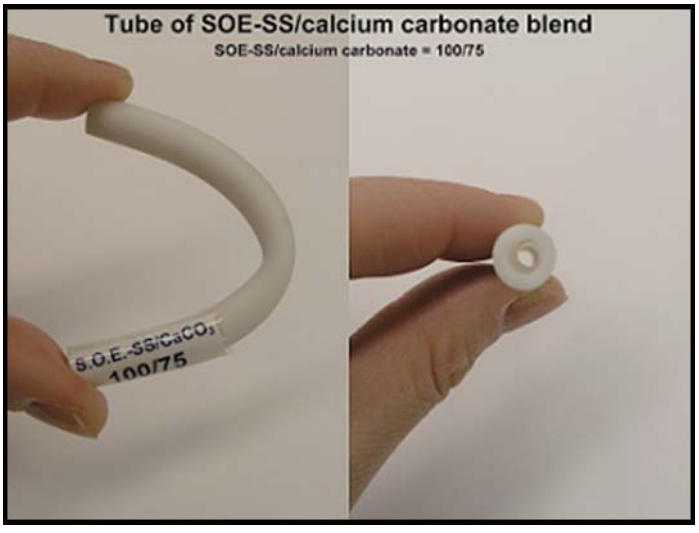
- S.O.E.™ accepts large quantity of inorganic filler without significant loss of flexibility.
- High-filled S.O.E.™ formulation can provide lower cost compounds.
- S.O.E.™ accepts large quantity of flame retardants such as $Mg(OH)_2$.
- S.O.E.™/$Mg(OH)_2$ compound at 45/55 dosage attains rating equivalent to UL-94 V-0 with 2 mm thickness.
- S.O.E.™ shows high compatibility with other polyolefins such as EVA or PE. Formulation of S.O.E.™/inorganic filler/polyolefin is applicable.

Hardness vs filler content in S.O.E.™/ filler formulation



Tube made with S.O.E.™

S.O.E.™/$CaCO_3$=100/75

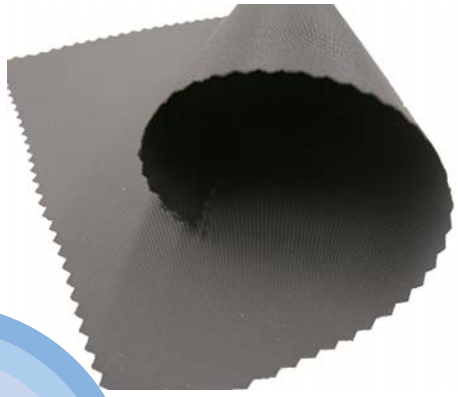


5. Artificial leather

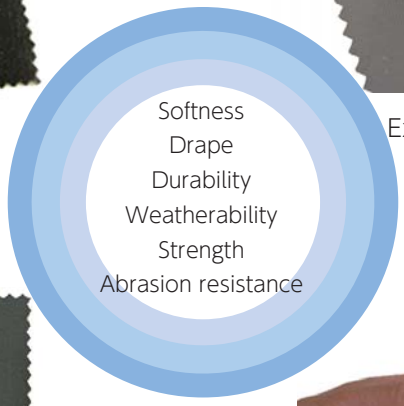
S.O.E.™ can be used as substitutes for various kinds of flexible PVC/PU artificial leathers by blending with polyolefin resins.

Applications of artificial leathers: car seats, shoe uppers, external and internal layer of handbags and briefcases, furniture, tablecloth, etc.

Car seats



External/internal layer of bag



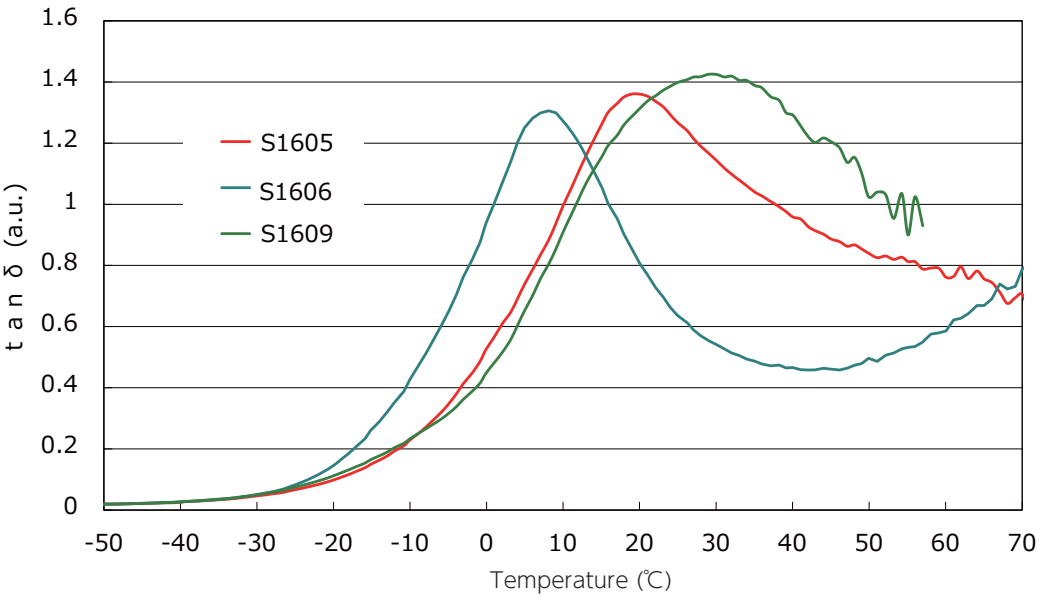
Artificial leather for furniture

Transparent sheet

6. Asphalt modification

S.O.E.™ series have superior compatibility with asphalt.
S.O.E.™/asphalt compound is effective for vibration-damping due to tan δ peak at room temperature.

Viscoelastic property of S.O.E.™/asphalt compounds



Composition: S.O.E.™／ Straight asphalt 60-80＝15/85
Device: ARES2 (Torsion Rectangular)
Measurement condition: Frequency=6.28rad/s
Strain=0.5%

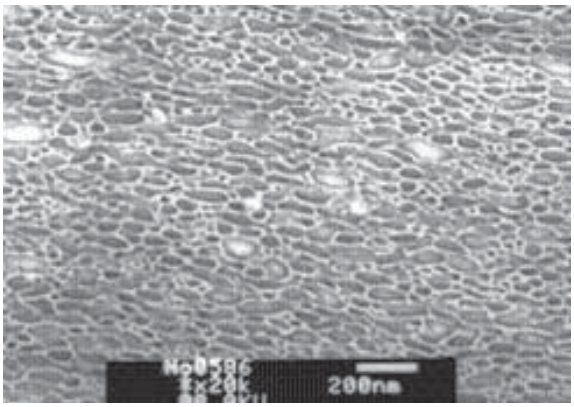
Tan δ of S.O.E.™ / asphalt compounds

Grade	Neat Polymer		Compound (S.O.E.™/AS=15/85)	
	tan δ	tan δ	tan δ	tan δ
	Peak temperature (℃)	Peak value	Peak temperature (℃)	Peak value
S1605	17	1.55	19	1.36
S1606	-13	1.72	8.1	1.31
S1609	19	1.31	29	1.43

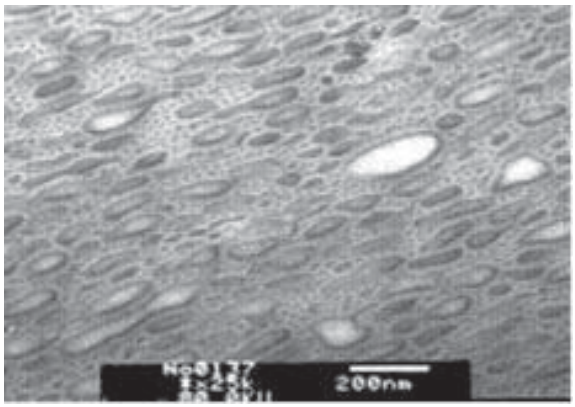
7. Polyphenylene Ether (PPE) Modification

S.O.E.™ has excellent compatibility with PPE.
S.O.E.™ can make the particle size of PPE small and provide flexible PPE compounds.
It also enables development of flexible and flame retardant compounds by formulating with phosphorus flame retardants.

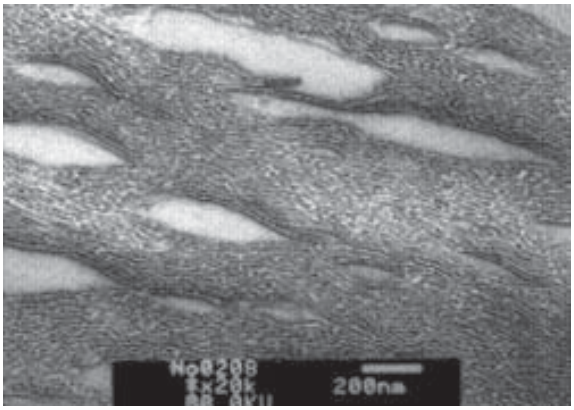
TEM photographs of PPE/S.O.E.™ and regular SEBS compounds



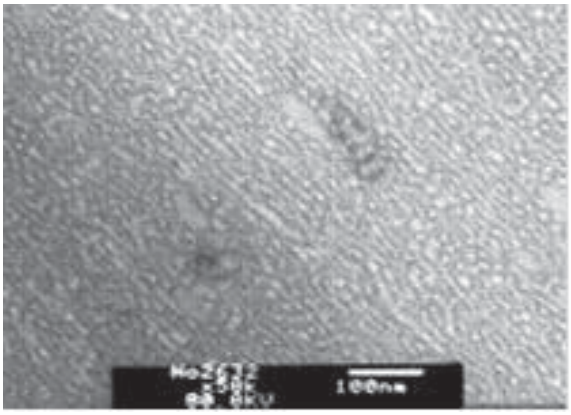
S1605+PPE compound



S1606+PPE compound



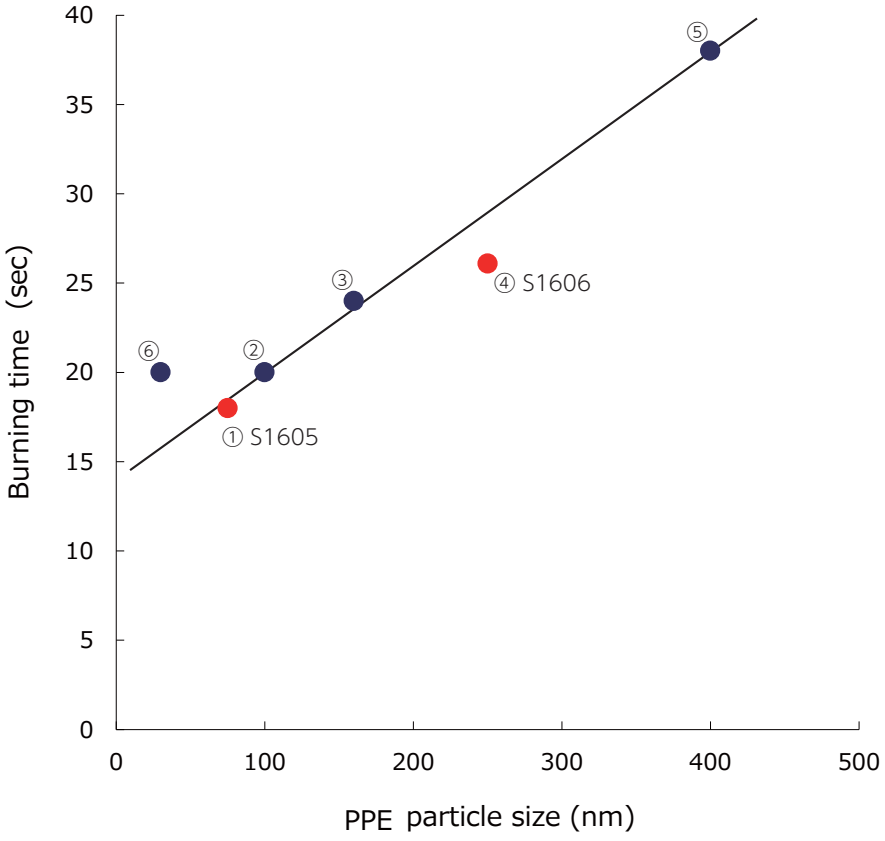
SEBS (Styrene content 30%)+PPE compound



SEBS (Styrene content 67%)+PPE compound

Relationships between PPE particle size and burning time of flame retardant compound

Composition	Hardness (Shore)	Average diameter of PPE particles (nm)	Burning time (sec)
① S1605	A88	75	18
② S1605/S1606=6/4	A90	100	20
③ S1605/S1606=4/6	A79	160	24
④ S1606	A76	250	26
⑤ SEBS (Styrene content 30%)	A97	400	38
⑥ SEBS (Styrene content 67%)	D73	30	20



4 Important Notes and Precautions

All information, data, and values contained herein are given as a representation in good faith of results obtained by the indicated test methods and of data, information, and documents currently available to Asahi Kasei Corporation (hereinafter "AKC"), for use only as a basic guide to grade selection for various applications and not as any explicit or implied warranty or guarantee of any nature, and are subject to change in accordance with changes in product properties and new findings or knowledge. It is the responsibility of the user to determine the safety and suitability of S.O.E.™ for the intended use, purpose, and application.

(1) Safe handling and use

Always observe the following general precautions and consult the Safety Data Sheets (SDS) issued by AKC, before handling or using S.O.E.™, and investigate and determine by advance testing the safety and suitability of any addition or mixing of any other resin, additive, or other material. It is the responsibility of the user to determine the safety and suitability of S.O.E.™ for the intended use, purpose and application.

①Hot and molten polymer

Avoid inhalation and eye or skin contact with any gases generated in heating or melting S.O.E.™ and with the hot or molten polymer. Employ local ventilation and protective gear, including chemical goggles and protective gloves, during any heating or melting operation.

②Combustibility

S.O.E.™ is flammable and must be kept strictly away from heat, sparks, and flame during handling and storage. In the event of its combustion, carbon monoxide and other toxic combustion gases may be generated; extinguish with water or with foam or dry chemical extinguisher.

③Disposal

Dispose of S.O.E.™ in accordance with local and national law and regulations, by burning in a properly equipped incinerator or by burial in a properly designed landfill site. Note that carbon monoxide and other toxic gases may be generated during incineration. Do not release to sewers, ground, or any body of water.

④Storage

Store S.O.E.™ in a cool dark area away from direct sunlight, humidity, and moisture.

⑤Molding conditions

Appropriate temperatures and other conditions for the molding and extruding of S.O.E.™ vary with the resin grade and type of use. Consult AKC or its representatives for related information.

(2) Medical and food applications

Certain S.O.E.™ grades comply with hygienic standards. For any application involving extended bodily contact, medical devices and containers, or food packaging, contact AKC. AKC will not be responsible for any problem in connection with or arising out of any use performed without its consent.

(3) Patent infringement

AKC warrants only that the sale or use of S.O.E.™ does not in itself infringe any patent or other industrial property right relating thereto, but does not warrant against infringement by reason of its use in combination with other materials or in any process.

NO OTHER REPRESENTATION OR WARRANTY, EXPRESSED OR IMPLIED, WHETHER ORAL OR ARISING BY USAGE OF TRADE OR COURSE OF DEALING, SHALL BE GIVEN ANY LEGAL EFFECT by the provision of S.O.E.™ or this publication. AKC assumes no obligation or liability for injury or damage relating to or arising out of the use of S.O.E.™.

Asahi Kasei Corporation
Performance Products SBU, Thermoplastic Elastomer Division,
TPE Sales & Marketing Department 2
1-1-2 Yurakucho, Chiyoda-ku, Tokyo 100-0006 Japan
Phone +81-3-6699-3253 Fax +81-3-6699-3268

AKelastomer
Visit our website at
www.akelastomer.com

Revised on April 2019