TUFTEC™

H series SEBS
M series Modified SEBS
P series SBBS

Hydrogenated Styrenic Thermoplastic Elastomer

AsahiKASEI

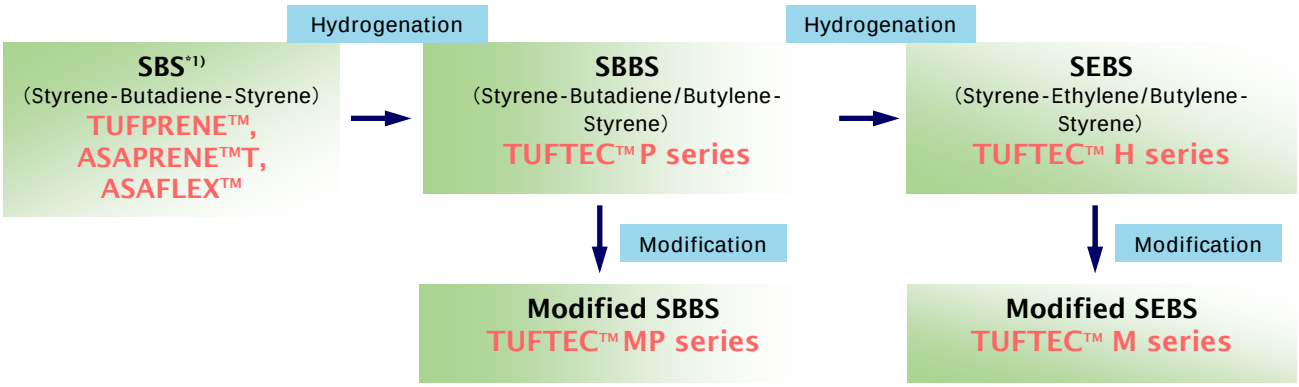
Table of Contents

1. Fundamentals

TUFTEC™ is a hydrogenated thermoplastic styrenic elastomer with excellent weatherability and heat resistance that is produced by hydrogenation of styrene and butadiene block copolymers.

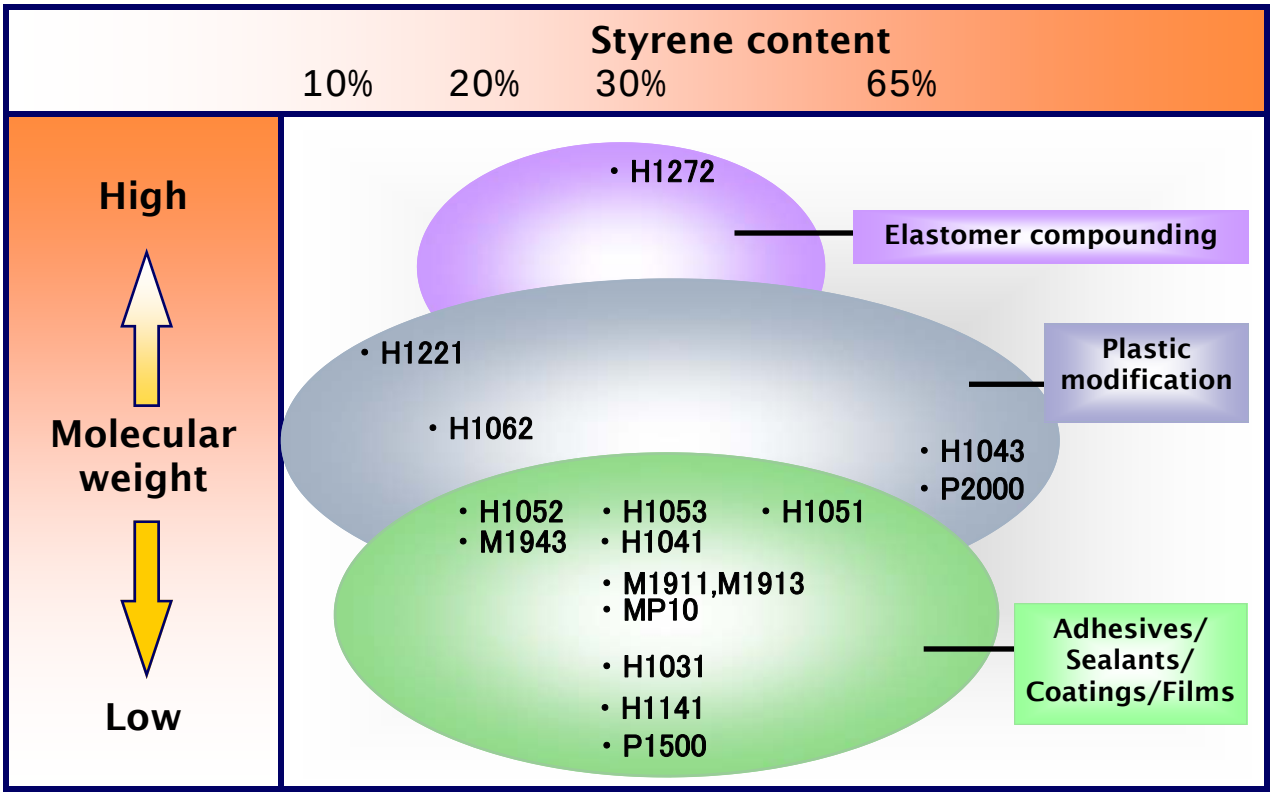
TUFTEC™ is the product of longstanding leadership in elastomers development and process technology at Asahi Kasei, beginning with its SBS elastomers and extending through the world-leading H-series SEBS elastomers, which were introduced in 1987 and then followed by the functional group-bearing M-series as the world's first modified SEBS elastomers.

TUFTEC™ P-series matches the rapidly diversifying market needs. It is produced by highly selective partial-hydrogenation of the SBS polymer, resulting in higher heat resistance than SBS elastomers and greater processability and low-temperature properties than fully-hydrogenated SEBS elastomers, in addition to the inherent polymer characteristics and properties.



*1) Information on TUFPRENE™, ASAPRENE™T, and ASAFLEX™ is given in separate brochures.

TUFTEC™ Polymer Grades / Application Map



2. Salient Features of TUFTEC™ H Series

- ◆ Thermoplastic elastomers with the high elasticity and strength comparable to vulcanized rubber.
- ◆ Excellent weatherability and heat-aging resistance.
- ◆ Rubber elasticity retention over broad temperature range.
- ◆ Excellent flex resistance.
- ◆ Excellent chemical (acid, alkali, and alcohol) resistance
- ◆ Low specific gravity - 0.89 to 0.91.
- ◆ Excellent compatibility with styrenic and olefinic resins, imparting high impact strength.

3. TUFTEC™ H Series Grades and Properties

Grade No.				H1031	H1041	H1043	H1051	H1052	H1053	H1062	H1141	H1221	H1272
Property	Test method	Test condition	Units	Non-oil extended									Oil ex-tended
Specific gravity	ISO 1183	-	-	0.91	0.91	0.97	0.93	0.89	0.91	0.89	0.91	0.89	0.90
S/EB weight ratio	Asahi Kasei method	-	%	30/70	30/70	67/33	42/58	20/80	29/71	18/82	30/70	12/88	35/65
MFR	ISO 1133	230°C 2.16kgf	g/10min	150	5.0	2.0	0.8	13	1.8	4.5	140	4.5	-
		200°C 5kgf	g/10min	80	3.5	5.0	0.5	10	-	-	-	-	-
		190°C 2.16kgf	g/10min	17	0.3	-	-	3	-	-	22	-	-
Hardness	ISO 7619	Durometer Type A	-	82	84	72[*1)]	96	67	79	67	84	42	35
Tensile strength	ISO 37	#3 dumbbell, 500mm/min	MPa	12.7	21.6	10.3	32.3	11.8	24.6	15	2.7	9.5	18.6
Elongation			%	650	650	20[*2)]	600	700	550	670	520	980	950
300% Tensile stress			MPa	3.2	3.4	-	8.3	2.5	4.8	4.3	2.8	1.0	1.0
Heat resistance: Maintained ratio of tensile strength	ISO 188	Normal oven method 120°C 168 hrs	%	-	97	99	-	99	98	97	100	-	98
Heat resistance: Maintained ratio of elongation			%	-	101	96	-	98	98	100	97	-	99
Heat resistance: Discolora-tion			-	-	slight change	slight change	-	slight change	slight change	slight change	slight change	-	slight change
Features				Low viscosity	High MFR	High styrene	High styrene, Tensile strength	Low styrene, High MFR	Tensile strength	Low temp. property	Coupling polymer	High vinyl, Low styrene	High molecular weight
Applications	PP modifier				●			●		●		●	
	PPE, PS modifier				●	●	●		●				●
	Compatibilizer				●	●			●				
	Multilayer films							●		●		●	
	Adhesives & sealants			●	●			●	●	●	●	●	
	TPE compounds							●		●		●	●

*1Type D *2#3 dumbbell 10mm/min

4. TUFTEC™ M series—Salient features

◆ Reactive elastomers with the same basic properties as H-series.

◆ Functional groups impart:

・Excellent compatibility with engineering plastics

・Excellent adhesion to metals and plastic substrates

5. TUFTEC™ M series—Grades and properties

Grade No.					M1911	M1913	M1943	MP10
Property		Test method	Test condition	Units	Acid modified			Amine-modified
Acid number		Titration method	—	mgCH3ONa/g	2	10	10	-
Specific gravity		ISO 1183	-	-	0.91	0.92	0.90	0.91
S/EB weight ratio		Asahi Kasei method	-	%	30/70	30/70	20/80	30/70
MFR		ISO 1133	230℃ 2.16kgf	g/10min	4.5	5.0	8.0	4
			200℃ 5kgf	g/10min	3.5	4.0	6.0	-
Hardness		ISO 7619	Durometer type A	-	84	84	67	89
Tensile strength		ISO 37	#3 dumbbell 500mm/min	MPa	22	22	11	28
Elongation				%	650	600	650	600
300% Tensile stress				MPa	4.1	4.4	2.9	5.6
Tensile modulus		ISO 527	500m/min	MPa	20	25	6.9	-
Heat resistance	Maintained ratio of tensile strength	ISO 188	Normal oven method 120℃ 168hrs	%	99	98	99	-
	Maintained ratio of elongation			%	96	95	96	-
	Discoloration			-	Slight change			
Base polymer					H1041	H1041	H1052	-
Features					Low modification	High modification	Low styrene, High modification	Terminal modification
Physical form					Pellet			

6. TUFTEC™ P series—Salient Features

- **Superior to SBS in heat resistance**
- **Superior to SEBS in processability and low-temperature properties, if molecular weight and styrene content are the same.**

Grade-specific features

★ TUFTEC™ P1500 : Excellent as base polymer for adhesives

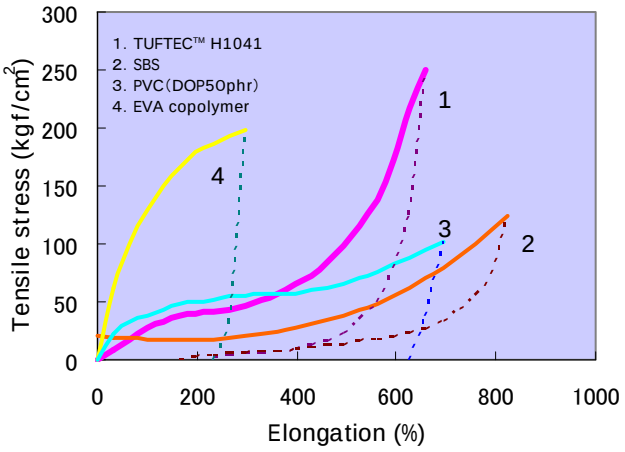
★ TUFTEC™ P2000 : Excellent for compatibilizing styrenic and olefinic resins

7. TUFTEC™ P series—Grades and Properties

Grade No.				P1500	P2000
Properties	Test method	Test condition	Units		
Specific gravity	ISO 1183	-	-	0.94	0.98
S/BB ratio	Asahi Kasei method	-	wt%	30/70	67/33
MFR	ISO 1133	190℃ 2.16kgf	g/10min	4	3
		230℃ 2.16kgf		-	-
Solution viscosity		15% Toluene	mPa.s	35	-
Hardness	ISO 7619	Durometer type A	-	69	-
		Durometer type D	-	-	74
Tensile strength	ISO 37	#3 dumbbell, 500mm/min	MPa	3.3	24.5
Elongation			%	780	42
300% Tensile stress			MPa	2.1	—
Physical form				Pellets	

8. Basic Properties of TUFTEC™

1. Stress-strain curves



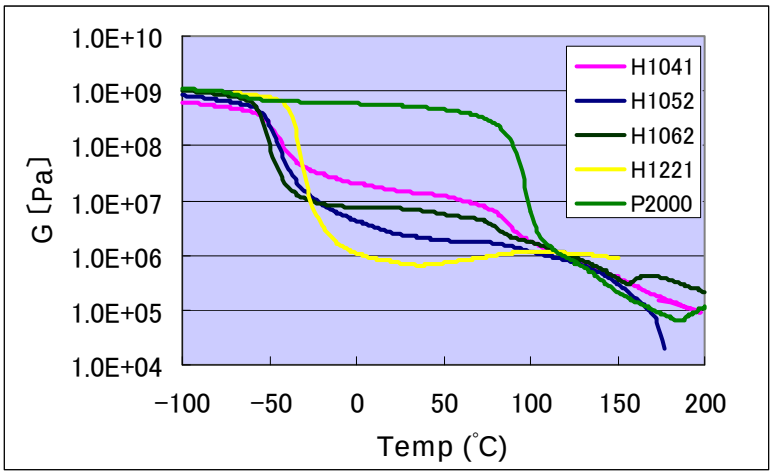
Test sample: 2 mm thickness compression molded
Test method: ISO 37, No. 3 dumbbell, 500 mm/min

2. Solubility in specific solvents

Soluble	Low or non-soluble
Cyclohexane	Ethanol
Toluene	Isopropanol
Xylene	Ethyl acetate
Diethyl ether	Ethyl cellsorb acetate
THF	MEK
Chloroform	

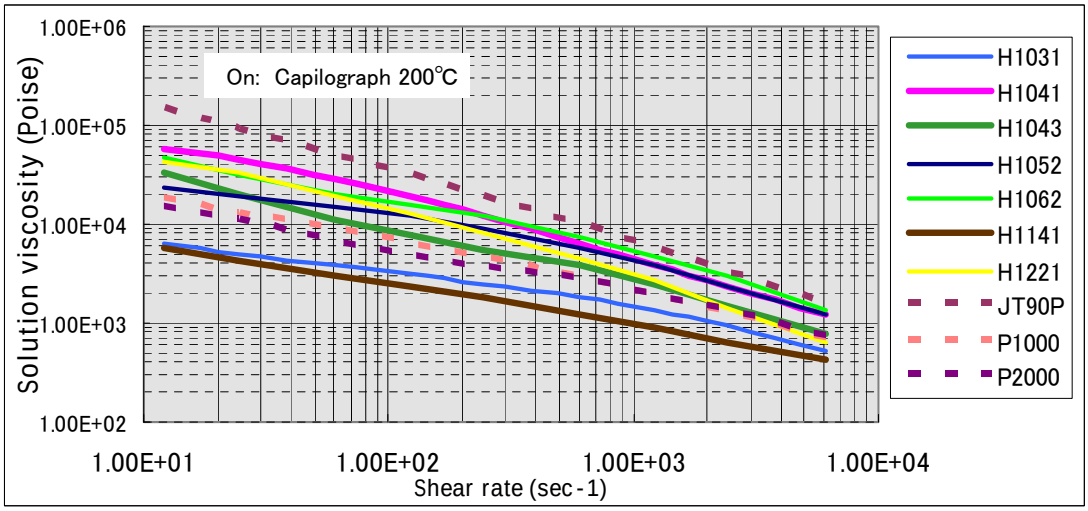
Note: TUFTEC™ swells strongly in gasoline, kerosene, and lubricating oils.

3. Elasticity vs. temperature



On : ARES2 mechanical spectrometer
Plate : ≤12.7 mm (W) x ≤5 cm (L) x 0.8~3.2 mm (T)
Mode: Dynamic temperature ramp

4. Viscosity vs. shear rate

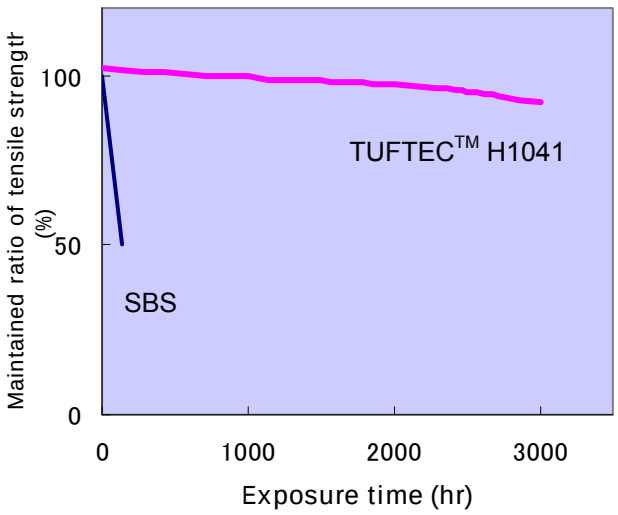


Low ← H1141<H1031<P1500、P2000<H1043<H1221、H1272、H1052<H1062、H1041<H1053<H1051<P3000 → High

8. Basic Properties of TUFTEC™

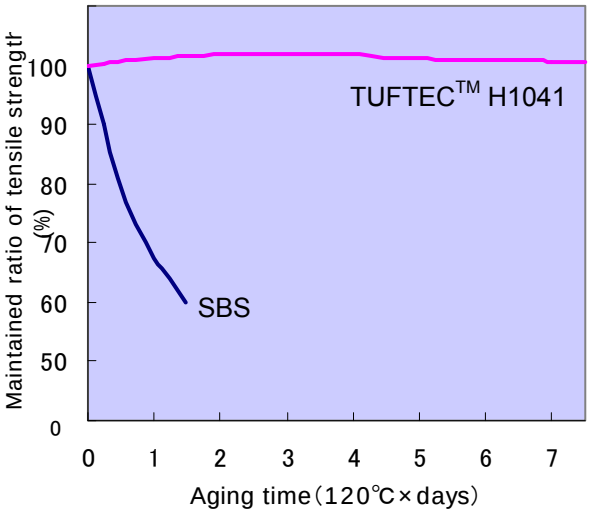
5. Weatherability

On Sunshine Weatherometer



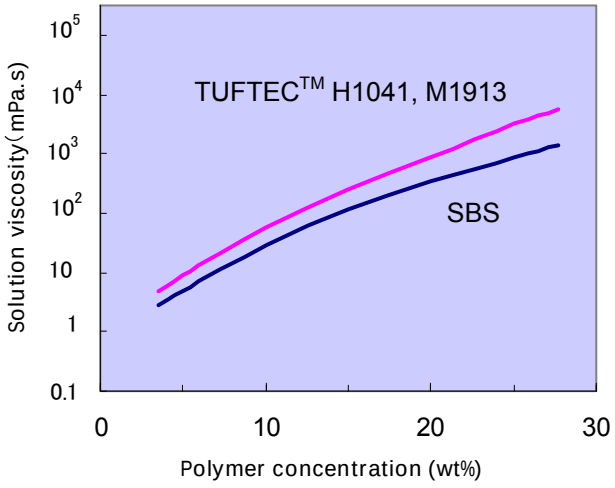
6. Heat-aging resistance

Gear aging test



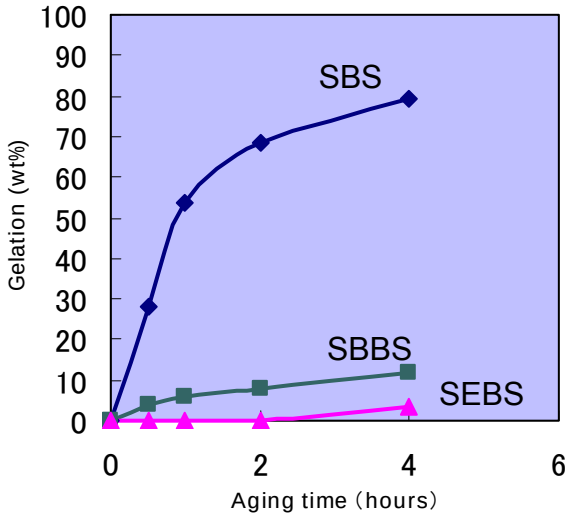
Test conditions
Weather-resistant formulations
Black panel temperature, 63℃

7. Toluene solution viscosity



Test conditions:
B-type viscosity meter @ 25℃

8. Heat resistance



Gelation ratio after aging at 200℃, with equal styrene contents

9. TUFTEC™—Applications and Recommended Grades

	Object Material	Effect	End Products	Recommended Grades		
				H series	M series	P series
Resin Modifier	PP	Enhancing impact strength	Bumpers, Instrumental panels, Food packaging	H1062 H1052		
		Softening the material	Electric cable sheathing, Elastic yarn and film, Hoses, Tubes	H1221 H1062 H1052 H1031	M1913 M1943	
	PPE	Enhancing impact strength and toughness	IC trays, CD-Rom Chassis, Wheel caps	H1051 H1053 H1272		
	PA	Enhancing impact strength and toughness	Electric connectors		M1913 M1943	
	PET	Enhancing impact strength and tough-ness	Toughning agent for recycled PET	H1051 H1053	M1913	
	Thermosets	Lowering shrinkage and enhancing impact strength	FRP bathtubs, FRP vanity cabinets, Artificial marble	H1031 H1041	M1913 M1943	
Compatibilizer	PP/PS PP/ABS PP/PPO	Enhancing ductility, Toughning recycled material	Microwavable food containers, Electric cable sheathing, Strengthening agent for recycling	H1041 H1043 H1051	M1913 M1943	P2000
Asphalt Modifier		Providing flexibility and good impact resistance with better thermal sta-bility in processing than SBS	Hot mopping asphalt roofing	H1053		P1500
Adhesives and Sealants			Adhesives for protective films, Adhesives for buildings and constructions, Hot melt adhesives for hygiene products, Sealants for automotives, Laminating materials for PS sheets, Adhesives for alminium and PP	H1221 H1052 H1041	M1913	P1500
Raw Material for TPE Compounds			Grips, ABS overmolded products, Air bag covers	H1272 H1062	M1913 M1943 MP10	

10. Use and Effect of TUFTEC™ as Resin Modifier

TUFTEC™ H series and M series, with their outstanding compatibility characteristics, are widely used to modify and to compatibilize both thermoplastic and thermoset resins and plastics.

- **◊ In blends with engineering and commodity plastics, for high impact strength or flexibility.**
- **◊ As reactive binders, to produce new alloys with special characteristeics, through compatibilization of previously unattainable polymer combinations.**
- **◊ As reactive modifiers of unsaturated polyesters, epoxies, and other resins particularly effective for improving the surface smoothness of SMC and BMC parts and for increasing the peel strength of epoxy-based adhesives.**

1. Basic guideline on effectiveness for different resin types

Engineering plastics	H series	M series
Polyamide (PA)	P	E
Polyesters (PEs)	P	G
Polyphenylene ether (PPE)	E	E
Polyoxymethylene (POM)	P	F
Polycarbonate (PC)	P	G
Polyphenylene sulfide (PPS)	G	G

Commodity plastics	H series	M series
Polyethylene (PE)	G	G
Polypropylene (PP)	E	G
Polystyrene (PS)	E	E
ABS	G	G
Polyvinyl chloride (PVC)	—	F

Thermoset plastics	H series	M series
Unsaturated polyester	G	—
Epoxy resin	—	E
Phenol resin	—	E
DAP resin	—	E

Rating index
E:Excellent, G:Good, F:Fair, P:Poor, —:No data

10. Use and Effect of TUFTEC™ as Resin Modifier

2. Polypropylene modification

TUFTEC™ H-series is effective for polypropylene modification. The optimum grade vary depending on the targeted characteristics of the end product, as illustrated below.

(1) Block PP modification with TUFTEC™ H1041

(2) Improving low-temperature properties of talc-filled PP with TUFTEC™ H1062

(3) Clear, flexible PP with TUFTEC™ H1221

(1) Block PP modification with TUFTEC™ H1041

As shown in this table, modification of block PP with TUFTEC™ H1041 can effectively increase softness and low-temperature impact strength. Adding the optimum amount of TUFTEC™ is the key to achieve the desired combination of stiffness and impact strength.

				Block-PP / TUFTEC™ H1041			
Property		Test method		100/0	85/15	70/30	55/45
MFR	g/10min	ASTM D 1238 (230℃, 2.16kgf)		1.9	2.3	2.9	3.9
Tensile strength	MPa	ASTM D 638		23	22	17	14
Elongation at break	%			700	600	570	540
Flexural strength	MPa	ASTM D 790	23℃	34	26	19	15
			50℃	20	15	11	8
			80℃	12	9	6	4
Flexural modulus	MPa	ASTM D 790	23℃	1,200	850	640	450
			50℃	640	490	350	240
			80℃	390	280	200	130
Izod impact strength*1	J/m	ASTM D 256	23℃	150	NB	NB	NB
			0℃	61	NB	NB	NB
			-10℃	52	NB	NB	NB
			-30℃	45	82	NB	NB
			-40℃	43	69	NB	NB
Hardness	Shore D	ASTM D 1706		72	68	63	56

*1 Izod impact test, NB:Non-breaking

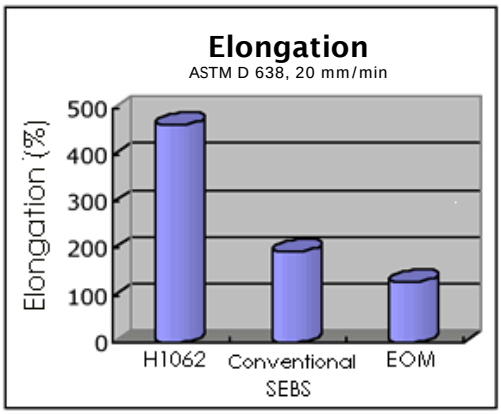
10. Use and Effect of TUFTEC™ as Resin Modifier

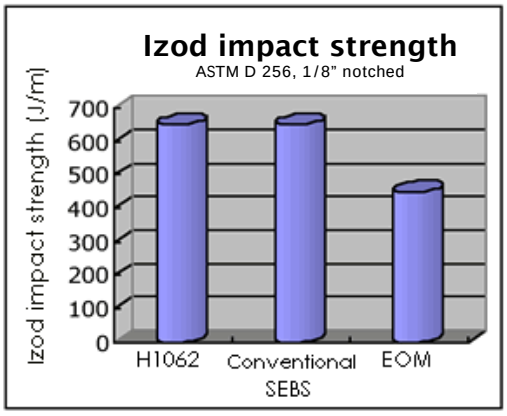
(2) Improvement of low-temperature properties of talc-filled PP with TUFTEC™ H1062

Block polypropylene with TUFTEC™ is superior in impact resistance, elongation, low-temperature brittleness, and their performance characteristics, as indicated by this comparison of TUFTEC™ H1062 with a conventional styrene-ethylene/butylene-styrene (conventional SEBS) and an ethylene/octene copolymer (EOM).

Block-PP modifier	H1062	Conventional SEBS	EOM
Brittleness Temperature (℃)	-32.3	-27.8	-17.4

Typical application of TUFTEC™ modified talc-filled PP compounds

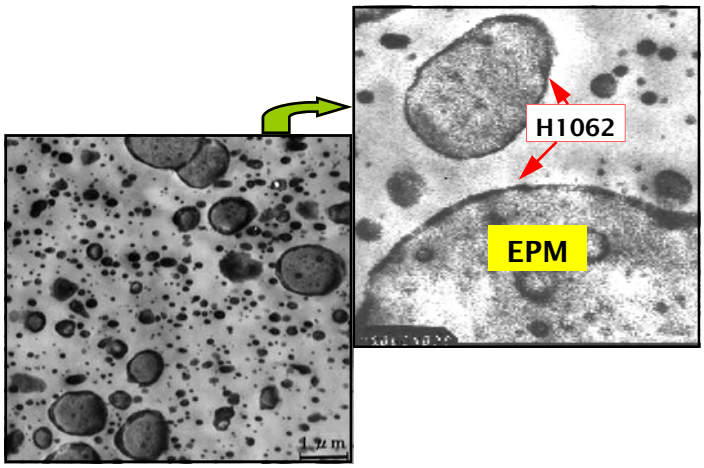


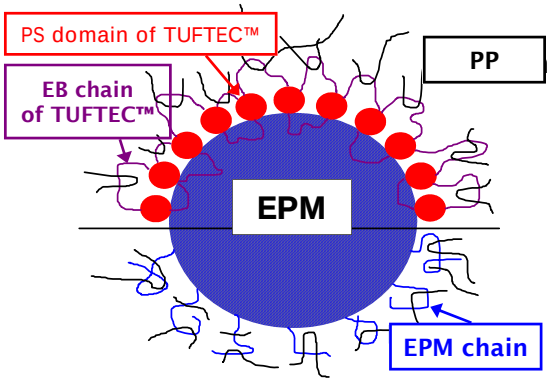


Formulation and compounding conditions
Formulation: PP, block copolymer (MFR 30) / TUFTEC™ H1062/talc=65/15/20
Compounding cylinder temp.: 210℃
Injection molding: Cylinder temp:230℃, Mold temp:40℃
Injection time: 10 sec, Cooling time: 30 sec

Homo PP/EPM/H1062 (80/15/5) morphology and mechanism

TUFTEC™H1062 encapsules the EPM rubber particles and enhances the interfacial adhesion between the polypropylene and EPM, stabilizing the blend morphology.

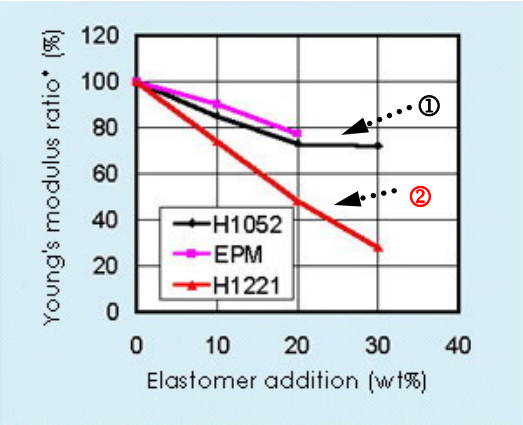


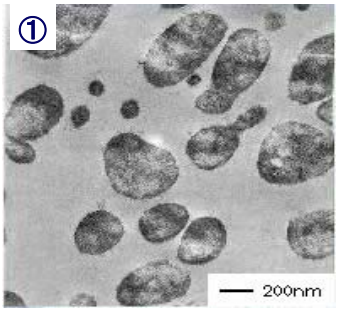


10. Use and Effect of TUFTEC™ as Resin Modifier

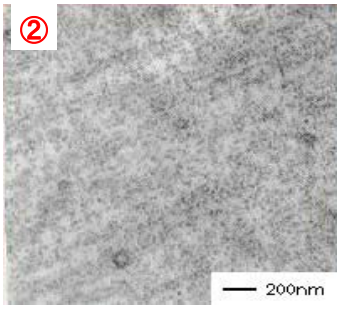
(3) Clear, flexible PP with TUFTEC™ H1221

As shown below, clear and flexible polypropylene can be obtained by adding TUFTEC™ H1221, due to its nanometer-order dispersibility in polypropylene.





PP/H1052 (80/20)
Young's modulus **700 MPa**



PP/H1221 (80/20)
Young's modulus **340 MPa**

Properties of TUFTEC™ H1221 and H1052 blends with PP

Homo PP (MFR 7.0 film grade with slipping agent)/ TUFTEC™ = 80/20

	Property	Units	TUFTEC™ H1052	TUFTEC™ H1221
	MFR (230 ℃, 2.16 kgf)	g/10 min	13	3
	Bound styrene	%	20	13
Sheet or Film	Young's modulus (MD/TD)	MPa	700/550	340/380
	Tensile yield strength (MD/TD)	MPa	7/6	5/5
	Tensile rupture strength (MD/TD)	MPa	18/18	13/13
	Elongation (MD/TD)	%	72/66	70/71
	Light transmission	%	91.5	92.4
	Haze	%	17.8	4.2
	Blanching, ΔT	%	33.3	3.2
Injection molding	Flexural modulus	MPa	1,100	710
	Tensile yield strength	MPa	29	23
	Tensile strength at break	MPa	21	28
	Elongation	%	730	530
	Brittle temperature	℃	<-30	-21.4

Applications

Truck covers

Carry bags

Logo mark line

Sheet or Film
Young's modulus: 20 mm X 100 mm X 70 μm, 2 mm/min
Light transmission and Haze: 70 μm thickness
Blanching: Light transmission loss under DuPont impact test
(0.4 mm thickness sheet, 1/2" missile, 1 kg load, 50 cm height)

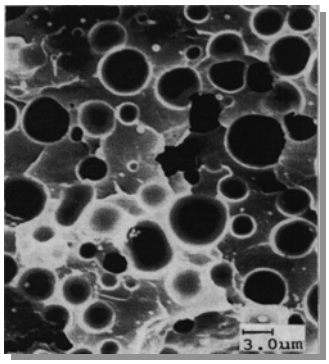
Injection molding
Flexural modulus: JIS K6758, bending speed 2 mm/min
Tensile properties: JIS K6758, tensile speed 50 mm/min
Brittleness temperature: JIS K7216

Blending condition
30 mmΦ twin screw extruder, 210 ℃, 200 rpm

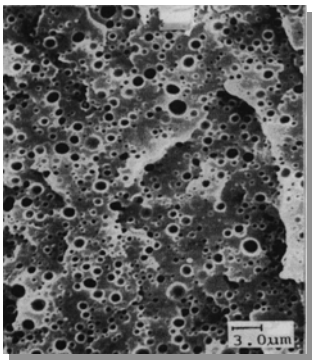
10. Use and Effect of TUFTEC™ as Resin Modifier

3. Polyamide modification

As shown by these two micrographs of modified nylon 6 (PA6) obtained under the same blending and extruding conditions, the TUFTEC™ M series enables the formation of significantly smaller dispersed particles than the TUFTEC™ H series, and far higher impact strength, due to the formation of a graft structure by the reaction of the TUFTEC™ M acid anhydride groups with the PA6 functional end groups.

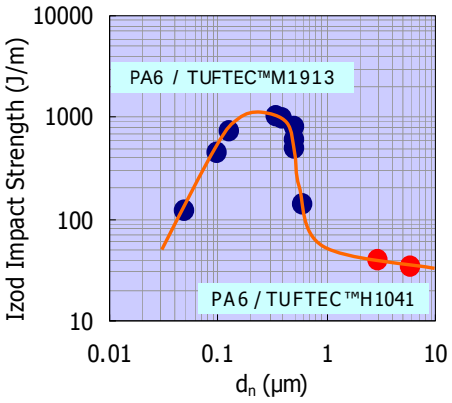


PA6 / TUFTEC™H1041
Izod impact strength 50 J/m



PA6 / TUFTEC™M1913
Izod impact strength 850 J/m

As shown on the right, maximum impact strength can be obtained by optimizing the size of dispersed particles, which is dependent on the PA6 end-group, the functional-group content of TUFTEC™ M, and the blending and extruding conditions.



4. Polycarbonate modification

Because of their modified polymeric structure, and the polarity of polycarbonate (PC), TUFTEC™ M series polymers exhibit a large effect on PC even when added in small quantities, as shown here in comparison with the non-modified TUFTEC™ H1041.

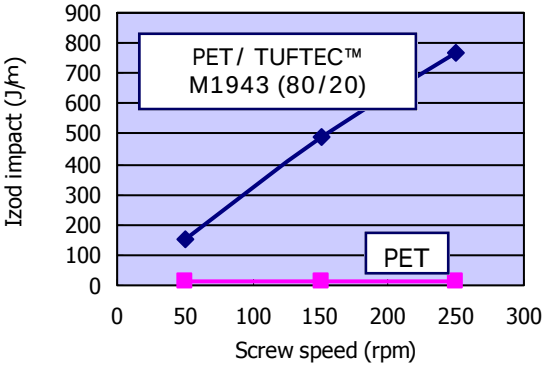
Material (Composition, wt%)	Izod impact strength 1/4" (J/m)	Tensile strength (MPa)	Flexural strength (MPa)	Flexural modulus (MPa)
PC	180	64	98	2,500
PC / TUFTEC™H1041 (97.5 / 2.5)	270	59	91	2,400
PC / TUFTEC™M1913 (97.5 / 2.5)	720	58	89	2,400
PC / TUFTEC™M1943 (97.5 / 2.5)	750	58	90	2,400

10. Use and Effect of TUFTEC™ as Resin Modifier

5. PET modification

The impact strength of PET can be increased substantially by TUFTEC™ M, as shown here for TUFTEC™ M1943, and the increase can be controlled by screw speed and other conditions.

Property	Units	PET	PET/TUFTEC™ M1943		
Screw speed	rpm	250	50	150	250
Izod impact strength @ 23 °C	J/m	16	150	492	769
Flexural modulus @ 23 °C	MPa	2380	1500	1520	1550



11. Use and Effects of TUFTEC™ as Compatibilizer

1. Compatibilization of styrenic and olefinic resins

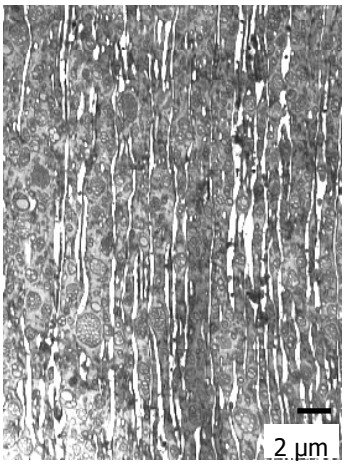
TUFTEC™H1043 and P2000 are high-performance compatibilizers for styrenic and olefinic resins. They enable,

1. co-continuous morphology in the compatibilized styrenic-olefinic alloy at styrenic rich compositions.
2. compatibility with ABS and polyphenylene ether, as well as with polystyrene.
3. outstanding compatibility with polypropylene and polyethylene.

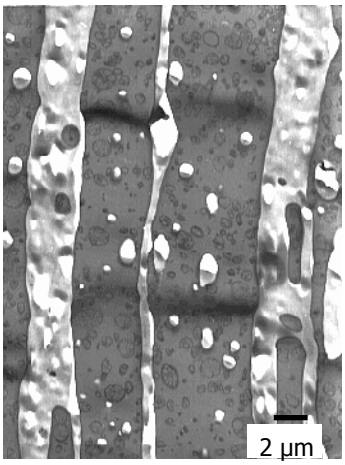
HIPS/PP/TUFTEC™ P2000 typical TEM micrographs

The TUFTEC™P2000 molecular structure is highly compatible with both HIPS and PP, enabling this extremely fine dispersion of PP into HIPS.

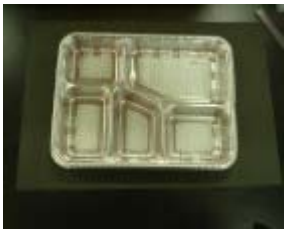
Matrix: HIPS (dark areas)
Dispersed particles: PP (white areas)
Samples:sheets (0.7 mm), Ruthenium-stained ultra-thin sections



HIPS / PP / TUFTEC™ P2000



HIPS / PP



HIPS/PP/TUFTEC™ film laminated food tray

Thermoformed food container

11. Use and Effect of TUFTEC™ as Compatibilizer

2. TUFTEC™ H compatibilization of HIPS and PP

Property	Units	Test method	Test condition	HIPS	PP	HIPS/PP without TUFTEC™ 70/30/0	HIPS/PP with H1041 70/30/6	HIPS/PP with H1043 70/30/6
Specific gravity		ISO 1183		1.05	0.90	0.99	0.99	0.99
MFR	g/10 min.	ISO 1133	200°C 5 kgf	6.6	8.5 *	25	13	13
Tensile strength	MPa	ASTM D638	5 mm/min.	30.4	26.5	26.5	23.5	28.4
Elongation	%	ASTM D638	5 mm/min.	19	>200	3	16	170
Flexural strength	MPa	ASTM D790	3 mm/min.	52	31	46	40	46
Flexural modulus	MPa	ASTM D790	3 mm/min.	2260	1080	1860	1570	1770
Izod impact strength	Kg-cm/cm	ASTM D256		7.5	12.0	4.4	11.2	7.2
HDT	°C	ASTM D648	4.6 kg	87	105	91	89	89
Vicat softening point	°C	ASTM D1525		106	150	110	108	108

3. TUFTEC™ P2000 compatibilization of styrenics and PP

Styrenic resin / PP relative proportions				PP / HIPS, GPPS or ABS / TUFTEC™P2000 30 / 70 / 0 or 10					
				PP					
				HIPS		GPPS		ABS	
Property	Units	Test method	Test condition	No TUFTEC™	TUFTEC™ P2000	No TUFTEC™	TUFTEC™ P2000	No TUFTEC™	TUFTEC™ P2000
Specific gravity	—	JIS K 7112	—	0.99	0.99	1.00	1.00	1.00	1.00
MFR	g/10 min.	ISO 1133	200°C, 5 kg	9.2	9	12.8	6.5	81 *1	57 *1
Tensile strength	MPa	ASTM D 638	5 mm/min.	26.0	31.6	31.0	46.0	29.7	38.0
Elongation	%	ASTM D 638	5 mm/min.	3	170	2	100	3	145
Flexural strength	MPa	ASTM D 790	2 min.	47	50	54 *2	75	50	66
Flexural modulus	MPa	ASTM D 790	2 min.	1,790	1,870	2,570	2,520	2,190	2,050
Izod impact strength	J/m	ASTM D256	notched	2.7	52	17	18	52	60

*1: 220 °C, 10 kg. *2: Rupture
PP: homopolymer, MFR=3.3 (230 °C, 2.16 kg).
HIPS: PSJ-Polystyrene 475D, MFR=2.0 (200 °C, 5 Kg). GPPS: PSJ-Polystyrene™ 685 by PS Japan, MFR=1.5 (200 °C, 5 kg)

4. Other combination with TUFTEC™ P2000

Information on the following combinations are also currently available on request.

1. Polystyrene/HDPE/TUFTEC™P2000
2. PPE+GPPS/PP or PE/TUFTEC™P2000

12. Use and Effect of TUFTEC™ in Adhesive Applications

As indicated below, TUFTEC™ H, M, and P series all provide excellent performance as the base polymer for a broad range of regular and pressure-sensitive adhesives.

1. Compatibility with tackifier resins

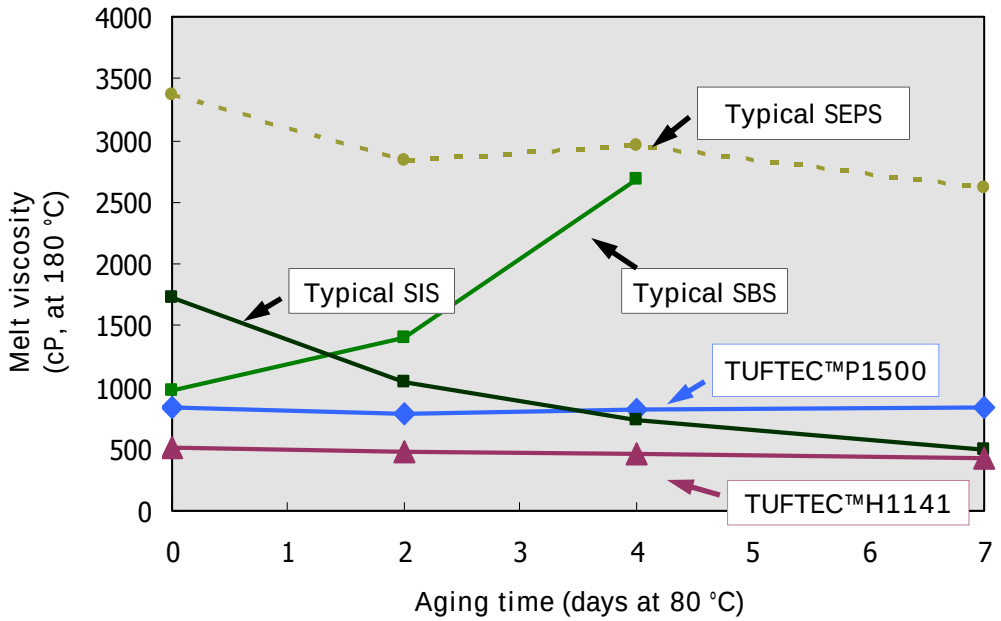
Compatibility of TUFTEC™ and other styrenic thermoplastics with typical tackifiers

Polymer / Tackifier	TUFTEC™ H (SEBS)	TUFTEC™ P1500 (SBBS)	SB type	SI type	SEP type
Alicyclic saturated hydrocarbon	F	G	N	G	G
Alicyclic hydrocarbon	N to F	G	G	G	F to G
Aliphatic hydrocarbon	G	G	N	G	G
Hydrogenated polyterpene	G	G	N	G	G

Compatibility rating: G: Good, F: Fair, N: Non-compatible

2. Thermal stability of pressure-sensitive adhesives

Thermal stability of typical pressure-sensitive adhesive formulations based on TUFTEC™ P1500, H1141 and other styrenic block copolymers, with an alicyclic hydrocarbon tackifier.



12. Use and Effect of TUFTEC™ in Adhesive Applications

3. Adhesive peel strength of neat polymers

Adherend	Press Temp. (˚C)	Adhesive Strength* (N /10 mm)		
		TUFTEC™ M1913	TUFTEC™ H1041	TUFPRENE™ A
		Modified SEBS	SEBS	SBS
Aluminum foil, 100 µm	200	53	4	11
PET film, 50 µm	180	10	1	0.4
Nylon 66 plate, 3 mm	180	24	1	8
Stainless steel plate, 2mm	200	39	8	16
Steel plate, 2 mm	200	>60	11	47
EVOH plate, 2 mm	140	43	3	0.4
Glass plate	200	23	0.4	3

Adhesion process: Place neat polymer on adherend, 5 min pre-heating, 5 min press under 1 kgf/cm² load, 3 min cooling.
Peeling procedure: T-shape peeling for film or foil adherend, 180-degree peeling for plates Peeling speed 200 mm/min, at room temperature.
*Adhesive layer: 200 µm

4. Tackifier selection

Adhesion characteristics with typical tackifiers

Formulation (411 parts in total)
Polymer :100 phr
Tackifier :250 phr
Paraffin oil (PW380) : 60 phr
Stabilizer :1 phr

Tackifier	TUFTEC™ grade	Melt viscosity @180˚C (mPa.s)	Softening point (˚C)	Adhesive properties (versus SUS304)		
				Loop tack (N /15 mm)	Adhesive strength (N /10 mm)	Holding Power @65˚C (hours)
Alicyclic hydrocarbon	H1141	600	91	0.8	16.1	1.9
	P1500	830	107	4.4	15.9	6
Alicyclic saturated hydrocarbon	H1141	520	92	3.1	16.3	6
	P1500	840	103	14.1	17.3	20
Aliphatic hydrocarbon	H1141	480	92	15.8	14.5	10
	P1500	860	106	17.7	18.6	25
Hydrogenated polyterpene	H1141	850	101	0.1	17.2	7
	P1500	1,830	119	0.1	17.6	15

How to make adhesive composites: Blending in toluene solution
Tape formation: Coating adhesive composites on PET film with 50 µm thickness

13. 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 Chemicals Corporation (hereinafter "AKCC"), 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 TUFTEC™ for the intended use, purpose, and application.

1. Safe handling and use

Always observe the following general precautions and consult the Material Safety Data Sheets (MSDS) issued by AKCC, before handling or using TUFTEC™, 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 TUFTEC™ for the intended use, purpose and application.

1) Hot and molten polymer

Avoid inhalation and eye or skin contact with any gases generated in heating or melting TUFTEC™ 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.

2) Combustibility

TUFTEC™ 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.

3) Disposal

Dispose of TUFTEC™ 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.

4) Storage

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

5) Molding conditions

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

2. Medical and food applications

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

3. Patent infringement

AKCC warrants only that the sale or use of TUFTEC™ 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 TUFTEC™ or this publication. AKCC assumes no obligation or liability for injury or damage relating to or arising out of the use of TUFTEC™.

January 25, 2010

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