

INTRODUCTION

Adhesive manufacturers use a large percentage of styrene-isoprene-styrene block copolymers (SIS) in their pressure sensitive adhesive formulations. While alternatives to styrene-isoprene-styrene block copolymers (SIS) do exist, they generally cannot be compounded with the same tackifiers and do not exhibit the same long-term stability as adhesives based on SIS. Eastman Chemical Company has developed various PSA formulations that substitute SIS copolymers with various alternatives. These formulation concepts could be used to manage the SIS content in adhesive formulations when commercial circumstances require a new strategy. Substitutes for traditional SIS block copolymers evaluated in this study include:

- SIS copolymers with high styrene content in conjunction with low softening point, and highly aromatic-modified hydrocarbon tackifiers.
- Styrene-isoprene-butadiene-styrene (SIBS) block copolymers with a high styrene content in conjunction with a low softening point, highly aromatic-modified hydrocarbon tackifier.
- SIS block copolymers diluted with SBS block copolymers in conjunction with aromatic-modified, and aliphatic hydrocarbon tackifiers.
- SIBS block copolymers in conjunction with a suitable aromatic-modified aliphatic hydrocarbon tackifier.
- SIS block copolymers diluted with amorphous polyolefin (APO) and a suitable hydrogenated aliphatic hydrocarbon tackifier.

Each of these approaches requires the use of Eastman specialty products which may not be familiar to PSA formulators. The following information presents test data generated to illustrate the use of these products in a PSA tape formulation. The Eastman products highlighted in this work include:

- ***Piccotac 7050 Hydrocarbon Resin*** – A highly aromatic-modified, aliphatic resin with an unusually low softening point and glass transition temperature (T_g) plus excellent compatibility with SIS, SIBS, and SBS block copolymers. Due to its unique properties, *Piccotac 7050* can be used at a higher level than typical hydrocarbon tackifiers and its high level of aromatic modification can permit the use of block copolymers with higher styrene content.
- ***Piccotac 7590 Hydrocarbon Resin*** – An aromatic-modified, aliphatic resin with excellent properties as a tackifier for SIBS block copolymers. With a softening point and T_g in the typical range for a PSA tackifier, *Piccotac 7590* permits the formulation of adhesives within traditional composition ranges for minimum impact on application conditions and material balances.
- ***Eastoflex Amorphous Polyolefin E1060 (APO)*** – An amorphous propylene-ethylene copolymer that can be used to partially replace polymer in SIS or SEBS systems while maintaining most of the critical adhesive performance properties.
- ***Eastotac Resin H-100R*** – A hydrogenated aliphatic hydrocarbon tackifier with unique compatibility in SIS or SEBS systems extended with APO.

Reducing Isoprene Content in Pressure Sensitive Adhesives (TT-43D)

Table 1: Examples of PSA Formulations with Reduced SIS Block Copolymer Content

Formulas expressed in part per hundred parts rubber (phr)

Coated to 20 ± 2 grams/m² on 2 mil polyester film

Material	SIS Control	High Styrene SIS With Piccotac 7050	SIBS with Piccotac 7590	High Styrene SIBS with Piccotac 7050	SIS/SBS Blend with Piccotac 7590	SIS Extended with Eastoflex E1060 APO
<i>KRATON D-1161</i> ^a	100	—	—	—	80	70
<i>KRATON D-1165</i> ^a	—	100	—	—	—	—
<i>KRATON MD-6455</i> ^a Developmental SIBS	—	—	100	—	—	—
<i>KRATON MD-6460</i> ^a Developmental SIBS	—	—	—	100	—	—
<i>KRATON D-1118</i> ^a	—	—	—	—	20	—
<i>Piccotac 1095</i> Hydrocarbon resin ^b	100	—	—	—	—	—
<i>Piccotac 7050</i> Hydrocarbon resin ^b	—	160	—	160	—	—
<i>Piccotac 7590</i> Hydrocarbon resin ^b	—	—	130	—	120	—
<i>Eastotac Resin H-100R</i> ^b	—	—	—	—	—	120
<i>Eastoflex Amorphous polyolefin E1060</i> ^b	—	—	—	—	—	30
<i>Calsol 5550</i> Naphthenic process oil ^c	10	10	—	10	10	—
<i>Shellflex 451</i> Naphthenic process oil ^d	—	—	10	—	—	15
<i>Irganox 1010</i> Antioxidant ^e	0.5	0.5	0.5	0.5	0.5	0.5

^a*KRATON Polymers, Inc.*, ^b*Eastman Chemical Company* ^c*Calumet Lubricants Company*, ^d*Shell Chemical Company*, ^e*Ciba Chemical Company*

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Table 2: Adhesive Properties of Example Formulations with Reduced SIS Block Copolymer Content

Adhesive Property	SIS Control	High Styrene SIS with Piccotac 7050	SIBS with Piccotac 7590	High Styrene SIBS with Piccotac 7050	SIS/SBS Blend with Piccotac 7590	SIS Extended with Eastoflex E1060 APO
180° Peel, oz/in						
Initial mean (STDV)	71 (2.2)	79 (2.6)	60 (1.4)	53 (3.1)	72 (3.6)	85 (5.9)
Aged mean ^a (STDV)	69 (3.8)	47 (4.9)	39 (3.5)	36 (6.2)	60 (3.3)	71 (4.4)
180° Peel, N/25mm						
Initial mean (STDV)	20 (0.61)	22 (0.72)	17 (0.4)	15 (0.86)	20 (1.0)	24 (1.6)
Aged mean ^a (STDV)	19 (1.0)	13 (1.4)	11 (1.0)	10 (1.7)	17 (0.91)	20 (1.2)
Loop Tack, oz/in						
Initial mean (STDV)	99 (13)	92 (2.4)	109 (5.3)	39 (4.4)	82 (6.4)	36 (12)
Aged mean (STDV)	97 (8.6)	78 (6.8)	63 (1.4)	48 (5.9)	76 (4.3)	22 (8.1)
Loop Tack, N/25mm						
Initial mean (STDV)	28 (3.6)	26 (0.67)	31 (1.5)	11 (1.2)	23 (1.8)	10 (3.4)
Aged mean (STDV)	27 (2.4)	22 (1.9)	18 (0.4)	13 (1.7)	21 (1.2)	6.2 (2.3)
Rolling Ball Tack, cm						
Initial mean (STDV)	7.4 (2.2)	11.6 (1.2)	5 (1.3)	17.5 (6.6)	24.0 (4.8)	>45 (0)
Aged mean (STDV)	12.6 (3.8)	7.6 (3.5)	7 (1.0)	10.3 (5.0)	23.1 (6.2)	>45 (0)
40°C Hold Power, hours	>100	>100	>100	34.5	>100	111 ^b
Melt Viscosity, 177°C, cps	73300	4587	77200	5825	33250	1360
Ring & Ball Softening Pt., °C	129.4	126.4	90.3	116.5	114.6	83.9

^aAging conditions: 28 days@ 50°C, ^bRoom temperature hold power

CONCLUSION

These concepts are intended solely as initial work designed to evaluate combinations of materials to produce PSAs with properties similar to those of a control formula using KRATON D-1161. With these concepts, it is possible to extend the existing volume of SIS block copolymer. It is also important to note that these savings are partially realized due to higher resin loadings tolerated by the block copolymers in the cases of Piccotac 7050 and 7590 hydrocarbon resins. The formulator should recognize that these are starting point formulations ONLY and they must be further optimized by adjusting the proportions of oil and resin or by the introduction of co-tackifiers to develop specific adhesion properties.

For more information on the new SIBS elastomers available from KRATON Polymers, contact:

Kelon Morley, Global Market Development Manager
 Telephone: (832) 204-5408
 email: kelon.morley@KRATON.com

For more information on formulation strategies using tackifiers from Eastman, contact us at 1-800-EASTMAN or through the internet at www.eastman.com/adhesives.

Eastman Adhesives Raw Materials Technical Tip

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EASTMAN

NORTH AMERICA

Eastman Chemical Company Corporate Headquarters

P.O. Box 431
Kingsport, TN 37662-5280 U.S.A.

Telephone:

U.S.A. and Canada, 800-EASTMAN (800-327-8626)

Other Locations, (1) 423-229-2000

Fax: (1) 423-229-1193

www.eastman.com

LATIN AMERICA

Eastman Chemical Latin America

9155 South Dadeland Blvd.

Suite 1116

Miami, FL 33156 U.S.A.

Telephone: (1) 305-671-2800

Fax: (1) 305-671-2805

EUROPE / MIDDLE EAST / AFRICA

Eastman Chemical B.V.

Fascinatio Boulevard 602-614

2909 VA Capelle aan den IJssel

The Netherlands

Telephone: (31) 10 2402 111

Fax: (31) 10 2402 100

ASIA PACIFIC

Eastman Chemical Japan Ltd.

ALG Aoyama Building 5F

2-11-16 Minami Aoyama

Minato-ku, Tokyo 107-0062 Japan

Telephone: (81) 3-3475-9510

Fax: (81) 3-3475-9515

Eastman Chemical Asia Pacific Pte. Ltd.

#05-04 Winsland House

3 Killiney Road

Singapore 239519

Telephone: (65) 6831-3100

Fax: (65) 6732-4930

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