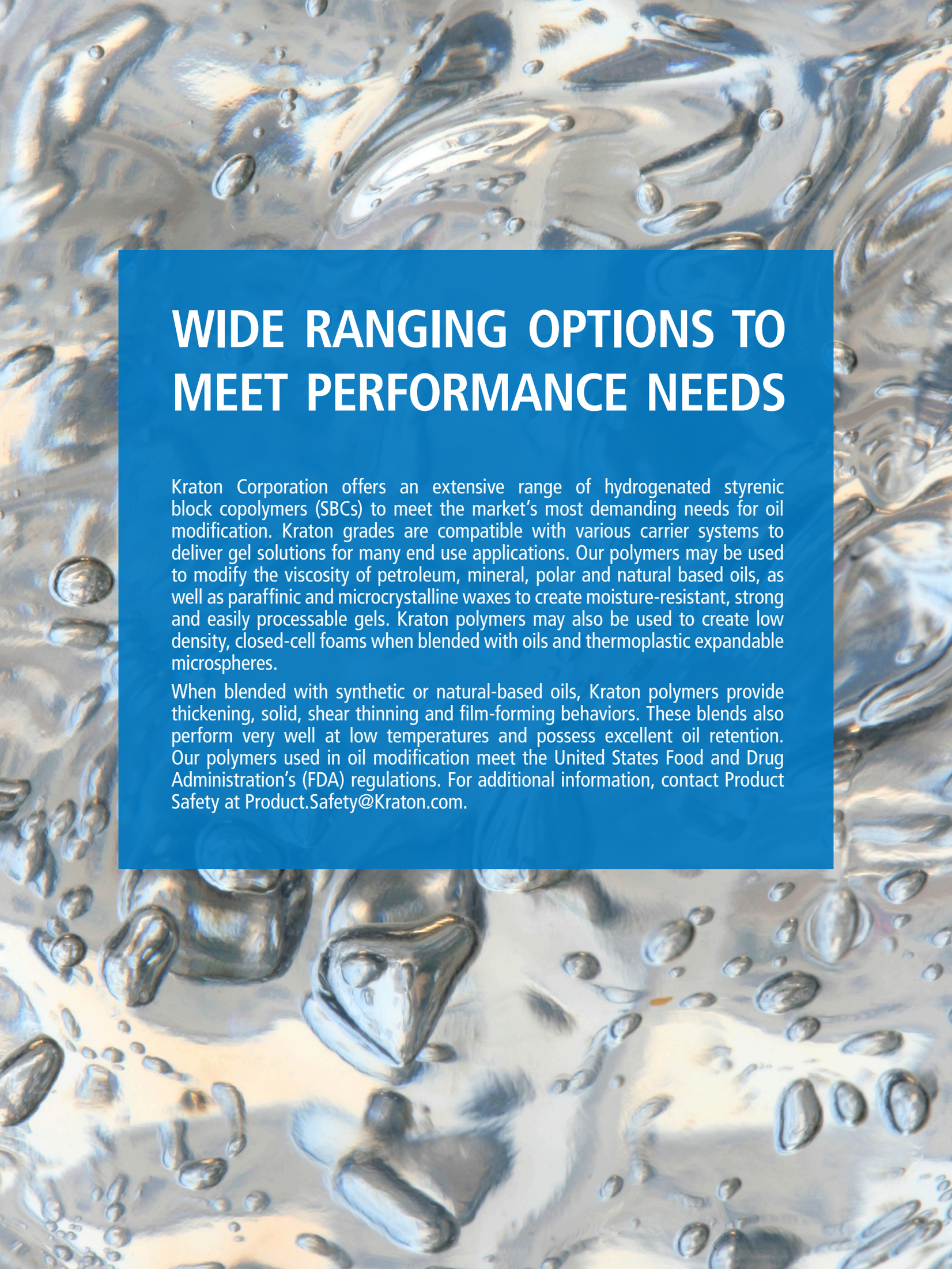
KRATON™ POLYMERS FOR OIL MODIFICATION

Versatile Solutions for Synthetic and Natural Based Oils

KRATON



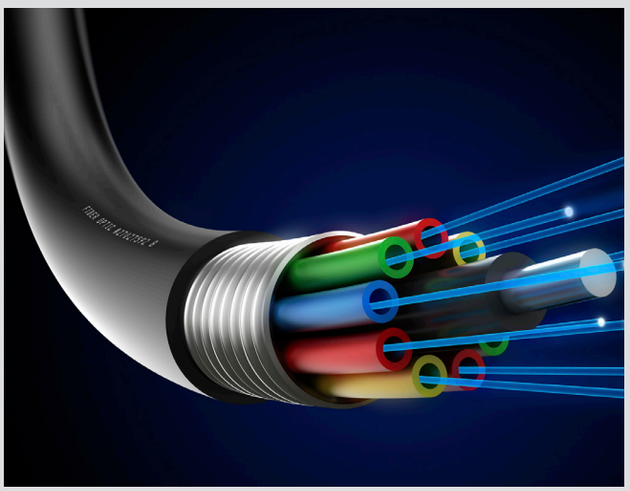
WIDE RANGING OPTIONS TO MEET PERFORMANCE NEEDS

Kraton Corporation offers an extensive range of hydrogenated styrenic block copolymers (SBCs) to meet the market's most demanding needs for oil modification. Kraton grades are compatible with various carrier systems to deliver gel solutions for many end use applications. Our polymers may be used to modify the viscosity of petroleum, mineral, polar and natural based oils, as well as paraffinic and microcrystalline waxes to create moisture-resistant, strong and easily processable gels. Kraton polymers may also be used to create low density, closed-cell foams when blended with oils and thermoplastic expandable microspheres.

When blended with synthetic or natural-based oils, Kraton polymers provide thickening, solid, shear thinning and film-forming behaviors. These blends also perform very well at low temperatures and possess excellent oil retention. Our polymers used in oil modification meet the United States Food and Drug Administration's (FDA) regulations. For additional information, contact Product Safety at Product.Safety@Kraton.com.

FEATURES & BENEFITS IN VISCOSITY MODIFICATION

Whether used as a sole rheology modifier, or to complement other gelling agents, Kraton polymers offer a variety of features and benefits. They provide elasticity, excellent moisture barriers and other outstanding properties over a wide range of temperatures. Additionally, our polymers may be directly dissolved in heated oil. Kraton™ G and Kraton™ A polymers can create viscous oils, greases, or flexible solid gels depending on the polymer used, its concentration and the type of oil.



APPLICATIONS

- Cosmetic thickeners
- Cable-filling compounds
- Foam control agents (defoaming, antifoaming)
- Transparent, scented candles
- Orthopedic and external prosthetic devices
- Injection molded, or extruded "foamed" oil gels
- Sealants, coatings and energy damping

FEATURES & BENEFITS

- High level of formulation versatility
- Excellent compatibility with a variety of oils
- Broad range of rheological profiles
- High clarity
- Enhanced product stability
- High moisture resistance

KRATON™ G SEP & EP POLYMERS

Kraton G styrene-ethylene-propylene (SEP) polymers with a di-block structure can thicken mineral oils, while providing shear thinning behavior. Alternatively, Kraton ethylene/propylene (EP) star polymers increase the viscosity of oils without thixotropic behavior. When using these polymers to thicken oils, film formation is improved and a moisture barrier is created.

Property	G1701 (SEP) Diblock	G1702 (SEP) Diblock	G1750 (EP)n Star
Tensile Strength, MPa[1,2]	2	2	<0.3
300% Modulus, MPa[1,2]	-	-	-
Elongation at Break, %[1,2]	<100	<100	100
Hardness, Shore A (10 sec)[3]	64	41	11
Specific Gravity	0.92	0.91	0.86
Brookfield Viscosity[4] cps, 25% w	>50,000	50,000	8,700
10% w	-	280	140
Melt Index g/10 min. (5kg) 200 ˚C	<1	<1	8
230 ˚C	<1	<1	-
Styrene/Rubber Ratio	37/63	28/72	0/100
Physical Form	Powder	Powder	Bale
Diblock, %	100	100	-
Comments	FDA	FDA	FDA

(1) ASTM method D412 tensile tester grip separation speed 10 in./min.
(2) Typical properties determined on film cast from toluene solution.
(3) Typical values on polymer compression molded at 177 ˚C.
(4) Neat polymer concentration in toluene, 25 ˚C.

These are typical values and should not be used to set specifications.

KRATON™ G SEBS

Kraton G styrene-ethylene-butylene-styrene (SEBS) polymers with a tri-block structure solidify mineral oils to provide strength, enhanced flexibility, and cushioning properties.

Property	G1633 (SEBS) Linear	G1650 (SEBS) Linear	G1651 (SEBS) Linear	G1652 (SEBS) Linear	G1654 (SEBS) Linear	G1657 (SEBS) Linear	G1726 (SEBS) Linear
Tensile Strength, MPa[1,2]	-	35	>28	31	>27	23	2
300% Modulus, MPa[1,2]	-	5.6	-	4.8	-	2.4	-
Elongation at Break, %[1,2]	-	500	>800	500	>800	750	200
Hardness, Shore A (10 sec)[3]	-	72	70	69	63	47	70
Specific Gravity	0.91	0.91	0.91	0.91	0.92	0.91	0.89
Brookfield Viscosity[4] cps, 25% w	>50,000	8,000	>50,000	1,800	>50,000	4,200	200
10% w	-	50	1,800	30	400	65	10
Melt Index g/10 min. (5kg) 200 ˚C	<1	<1	<1	<1	<1	8	65
230 ˚C	<1	<1	<1	5	<1	22	>100
Styrene/Rubber Ratio	30/70	30/70	33/67	30/70	31/69	13/87	30/70
Physical Form	Fluffy Crumb	Powder/Crumb	Powder/Crumb	Powder/Crumb	Powder/Crumb	Dense Pellet	Dense Pellet
Diblock, %	<1	<1	<1	<1	<1	29	70
Tg of Rubber Block, C	-53	-53	-53	-53	-55	-35	-55
Comments	FDA	FDA	FDA	FDA	FDA	FDA	FDA

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KRATON™ G ERS POLYMERS

When mixed with mineral oils, Kraton G Enhanced Rubber Segment (ERS) polymers allow for softer, lower temperature processable gels. ERS polymers have lower softening points and may be useful for temperature sensitive formulations. Low viscosity oil gels may be achieved when using these particular grades.

Property	G1640 (ERS) Linear	G1641 (ERS) Linear	G1642 (ERS) Linear	G1643 (ERS) Linear	G1645 (ERS) Linear
Tensile Strength, MPa[1,2]	>20	>17	>21	>10	>10
300% Modulus, MPa[1,2]	4.5	4.3	-	-	-
Elongation at Break, %[1,2]	>800	>800	>1200	>600	60
Hardness, Shore A (10 sec)[3]	60	52	48	52	35
Specific Gravity	0.91	0.91	0.90	0.90	0.89
Brookfield Viscosity[4] cps, 25% w	>50,000	>50,000	>1,300	210	-
10% w	1300	-	-	-	-
Melt Index g/10 min. (5kg) 200 ˚C	<1	<1	<1	75	13
230 ˚C	<1	-	<1	19	3
Styrene/Rubber Ratio	32/68	33/67	21/79	19/81	13/87
Physical Form	Fluffy Crumb	Powder	Powder	Dense Pellet	Dense Pellet
Diblock, %	<1	<1	<1	7	7
Tg of Rubber Block, C	-38	-38	-38	-35	-38
Comments	FDA	FDA	FDA	FDA	FDA

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LOWER SOFTENING POINT ERS PROPERTIES

The following chart demonstrates the ring and ball softening point of Kraton polymers based oil gel (ASTM E28-67) at 6% and 10% weight in Drakeol™ 34 mineral oil. These are typical values and should not be used to set specifications.

SEBS	Drop Point (˚C)	
Polymer %	**6**	**10**
G1650	67.8	77.2
G1651	123	141
G1652	56.1	65.6
G1654	96.7	117
G1657	26.7	37.8
SEBS (ERS)	**Drop Point (˚C)**	
Polymer %	**6**	**10**
G1641	114	132
G1642	65.6	72.8
G1643	42.2[1]	45.6
G1645	47.8	50

[1] G1643 had bleed at 6% polymer

KRATON™ A POLYMERS

Kraton A polymers have a unique midblock structure that is compatible with natural, polar, and ester oils. Natural oils, such as almond, coconut, olive, rice bran, sesame seed, soybean, sunflower, olive, rapeseed, and walnut exhibit excellent compatibility with Kraton™ A1535 and A1536 polymers.

Property	A1535 Linear	A1536 Linear
Tensile Strength, MPa[1,2]	28	>34
300% Modulus, MPa[1,2]	7.9	6.4
Elongation at Break, %[1,2]	>600	660
Hardness, Shore A (10 sec)[3]	83	65
Specific Gravity	0.96	0.93
Brookfield Viscosity[4] cps,		
25% w	4,300	-
20% w	-	1,830
15% w	-	465
10% w	210	-
Melt Index g/10 min. 5kg/230 ˚C	<1	3
Styrene/Rubber Ratio	58/42	42/58
Physical Form	Powder	Powder
Diblock, %	<1	5
Tg of Rubber Block, C	-15	-25
Comments	FDA	FDA

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GEL BASED ON ESTER OILS

Aliphatic Ester Oils		
Composition, %w	**1**	**2**
Erucical™ EG-20	91	-
Erucical™ EG-20	-	91
Kraton A1535 polymer	-	9
R&B S.P. ˚C	91	56
Hardness		
Probe, gm	100	60
Shore 00	0	0
Oil Bleed	No	No

Erucical is a trademark of Vantage Specialties, Inc.
Finester is a trademark of Innospec Performance Chemicals US. Corp.

Aromatic Ester Oils		
Composition, %w	**1**	**2**
Finsolv™ TN	90	80
Kraton A1535 polymer	10	20
Viscosity at 25 ˚C	Low	High

Finsolv is a trademark of Innospec Performance Chemicals US Corp.

LOW DENSITY AND HIGH TEMPERATURE RESISTANCE

Kraton® G polymers may also be used to create low density foams when blended with oils and thermoplastic expandable microspheres. These foams can be thermoplastic or thermoset. Thermoset UV cured foams are more resistant to higher temperatures.

CLOSED CELL, LOW DENSITY GELS

Formulation, %w	1	2	3	4	5
Kraton G1654 polymer	10	9.5	9	8.5	8
Ondina™ N68 oil	90	89.5	89	88.5	88
Expancel™ D 091/80	0	1	2	3	4
Properties					
Density, g/ml	0.84	0.59	0.5	0.43	0.43
Drop Point	135	145	153	192	196
Viscosity, 100c (Pa.s)	1,300	6,100	10,800	18,500	21,500
Oil Bleed out ranking[1]	3	2	2	2	2

(1) Visual ranking: 1=no evidence of oil on filter paper, 2= filter paper wet with oil, 3= filter paper saturated with oil.
Ondina is a trademark of Shell Trademark Management B.V.
Expancel is a trademark of Casco Adhesives A.B. Corp.

These are typical values and should not be used to set specifications.

THERMOSET OIL GELS BY UV CURE

Formulation	%wt
Drakeol™ 7 oil	83.7
Kraton™ SBS polymer	7.5
Kraton™ G1650 SEBS polymer	7.5
SR 238 hexandiol diacrylate	1
Irgacure™ 819 BAPO photoinitiator	0.2
Plug Distortion after irradiation[1]	None
Oil Bleed Out[2]	No

(1) Gels were also exposed to fluorescent room light for one week. Plug distortion was prepared by putting 33 mm diameter plug in beaker in oven for 1 hour at 70 ˚C.
(2) Bleed on surface was noted after one month.
Drakeol is a trademark of Calumet Penreco, LLC.
Irgacure is a trademark of Ciba Specialty Chemicals Corp.
Sartomer SR 238 is a trademark of Sartomer Technology USA, LLC.

CREATING OIL GELS WITH KRATON POLYMERS

Kraton experts are available to provide technical assistance in regard to modifying the viscosity or mixing our polymers with oils. Recommendations may involve:

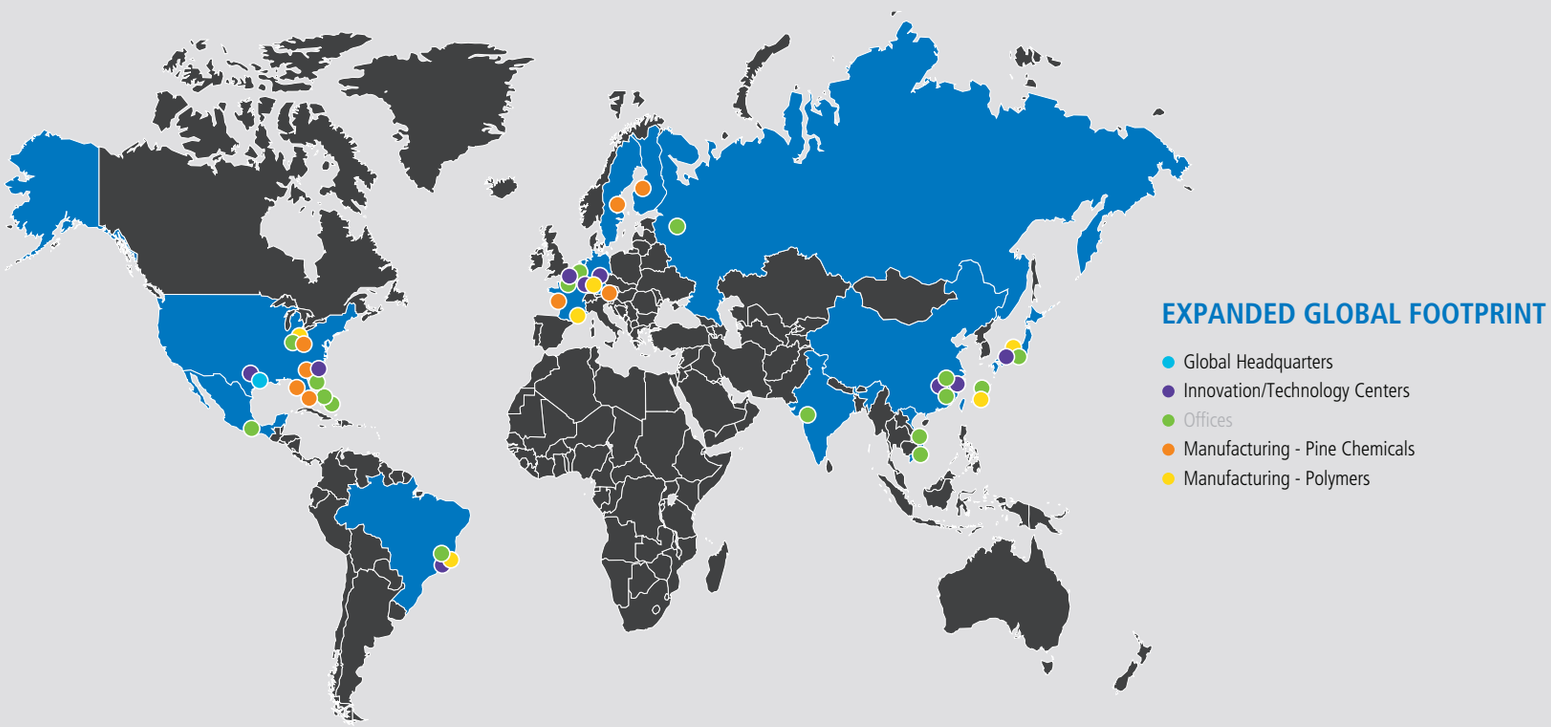
- Mixing time
- Mixing temperature
- Mixing shear rate
- Preparation of foamed gels
- Preparation of ultra-soft compounds

Kraton offers a diverse range of innovative, hydrogenated SBCs. Our polymers may be used as rheology modifiers to mineral, polar, natural, and ester oils that offer unique structure and film forming properties. They are suitable for solution or melt processing, and can be formulated with other polymers, resins, filters, pigments, oils, thickeners, waxes and stabilizers to obtain a desired balance of properties. We provide value-added solutions that are designed to meet your most stringent performance needs.

KRATON

Company Profile

Kraton Corporation (NYSE: KRA) is a leading global producer of styrenic block copolymers, engineered polymers and chemicals derived from pine wood pulping co-products that are used to enhance the performance of end-use products that touch our daily lives. Through its Polymer segment, Kraton offers value-enhancing products that are used in a wide variety of applications including consumer and personal care items, adhesives and coatings, electronics, medical supplies, automotive components, polymer modification, compounding solutions, and paving and roofing materials. Through its Chemical segment, Kraton offers specialty chemicals that serve key adhesive, tire and road & construction end-use markets, as well as a broad range of end use applications served through its Chemical Intermediates business. Kraton offers its products to a diverse group of customers in over 70 countries worldwide.



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