Highly Modified Asphalt (HiMA)
An Innovative Approach to Road Safety and Longevity
What is HiMA?
HiMA is simply Highly Modified Asphalt; a tool that can be used to solve a variety of problems in asphalt pavements.

What makes HiMA unique?
Conventional SBS polymers can be blended into bitumen at 7 to 8%, but compatibility is a problem in all but the softest bitumens and viscosity can be too high for a workable mix at conventional temperatures. Kraton™ D0243 polymer gives exceptional compatibility and low viscosity, which helps eliminate this problem.

HiMA is a tool that can be used to solve a variety of problems in asphalt pavements. It gives a combination of permanent deformation and fatigue cracking resistance that can be applied to: thinner structural pavements; thinner, longer lasting overlays; tougher, more crack resistant emulsion products, and high strain applications such as bridge decks.
Conventional SBS polymer loadings give improvements to properties, but as shown in Figure 1, the dominant phase is still the bitumen and so the properties are mostly like bitumen. However, if the polymer content increases, the phases invert so the “bitumen” now behaves much more like rubber.

This has a profound effect on physical properties. As shown, the softening point increases dramatically and mixture fatigue resistance leaps. The increase in polymer content, by 2-3 times, gives 1-2 orders of magnitude improvement in fatigue resistance.
Highly Modified Asphalt
The Solution for Thinner and Longer-Lasting Pavement

Structural Pavements

Up-front and life-cycle cost reduction, pavement durability, and environmental impact will continue to be key concerns for the roads industry. Kraton Performance Polymers has developed a solution to improve durability, and reduce costs and resource use when building or reconstructing roads.

Our highly modified asphalt technology for asphalt base courses allows pavement thickness reductions of 30–40% that may deliver cost savings up-front. Laboratory tests and Finite Element modeling by Delft University of Technology in The Netherlands has demonstrated that a 40% pavement thickness reduction may be feasible without increase in damage.

This concept is being validated at the National Center for Asphalt Technology (NCAT) at Auburn University in Opelika, Alabama, with exceptionally good results to date.

Pavement design calculations with software that includes both stiffness values and fatigue results for a given mix demonstrate that the results found at Delft University of Technology and NCAT can be predicted with the material parameters of a highly modified asphalt mix.
Badly cracked section of highway PR-092 in Paraná state, Brazil before rehabilitation

Highway PR-092 after 30.5 cm [12"] old asphalt pavement had been replaced with 16.5 cm [6 1/2"] highly modified asphalt; 45% thickness reduction applied

Before reconstruction: severe rutting in pavement on container loading area at the port of Napier, New Zealand

New Highly Modified Asphalt base course paved at the port of Napier, New Zealand

June 2010 – NCAT Section N8 conventional rehabilitation after 10 months, 4 MM ESALs. First crack appeared at 2.7 MM ESALs.

September 2011 – NCAT Section N8 HiMA rehabilitation after 13 months, 5.3 MM ESALs. Oklahoma will sponsor this section through the 2012 test track cycle to monitor deterioration and evaluate preservation strategies.
Kraton Polymers in India

DID YOU KNOW?

Kraton Polymers has been present in India since 1993. The Central Road Research Institute (CRRI) has conducted several successful road trials using our advanced polymer technology. Kraton™ D0243 was used by CRRI for developing Highly Modified Bitumen to reduce pavement thickness.

In addition, Kraton Polymers have commercially been used in airfield pavements including Leh and Gorakhpur as well as roads with sub-zero temperature in the state of Sikkim.

HiMA on Mumbai’s Eastern Expressway

The Municipal Corporation of Greater Mumbai (MCGM) has approved Kraton’s HiMA based bituminous concrete as wearing course; included in Schedule of Rates (SoR).

HiMA technology was paved on the following sections:

- Sion Flyover: Eastern Expressway Mumbai
- Hindmata Flyover: Eastern Expressway Mumbai
- Nana Lal Mehta Flyover: Eastern Expressway Mumbai
- Bellasis Flyover: Bellasis Road, Mumbai
Superior fatigue resistance, while maintaining high stiffness, is key to the concept of highly modified asphalt for thinner pavements.

To create adequate stiffness, hard base bitumen is used. The SBS modification boosts fatigue resistance.

Hard base bitumen in combination with a high SBS content can normally lead to workability and compatibility problems, but Kraton™ D0243 can be used in high concentrations without issues during mixing, paving and compacting. This technology also allows the use of softer base bitumen in rehabilitation to mitigate reflective cracking.

Features of Kraton D0243:

- Enables low viscosity binders
- Superior compatibility with a wide range of bitumens
- Self-crosslinking – eliminates the need for sulfur, no H₂S emission
- Proven track record in paving applications since 2006
- Global supply capability

Innovation in pavement design:

- 30-40% thickness reduction that delivers upfront cost savings
- Superior fatigue resistance and durability
- Allows for height restricted applications such as bridge underpasses
- Lower viscosity binder offers contractors greater ease-of-use and workability
- Eco-friendly solution consumes less raw materials and energy
- Delivers even greater durability and service life at standard thickness levels
**Thin Overlays**

The success of the lab and modeling work at Delft University of Technology combined with the test data generated at the NCAT pavement test track suggested that the HiMA technology could be promising for pavement preservation applications such as thin surfacing asphalt paving and bitumen emulsion surface treatments.

In 2011, the states of Minnesota, New Hampshire, and Vermont placed demonstration projects as part of the AASHTO TSP2 HiMA thin surface paving program sponsored by the National Center for Pavement Preservation at Michigan State University. The plant-produced mixes were sampled during field installation and tested at the Highways Sustainability Research Center (HSRC) located at the University of Massachusetts Dartmouth. All mixtures used a polymer modified asphalt binder consisting of a soft (PG -34) neat binder modified with 7.5% HiMA polymer. The performance characteristics of the HiMA mixes were determined in terms of resistance to reflective cracking, thermal cracking, rutting, and moisture damage. Resistance to reflective cracking was measured using the Texas Overlay Tester (OT), thermal cracking characteristics of the mixtures were measured using the Thermal Stress Restrained Specimen Test (TSRST), rutting characteristics were measured using the Asphalt Pavement Analyzer (APA), and moisture damage was measured using the Hamburg Wheel Tracking Device (HWTD).

According to the posted AASHTO TSP2 results, the HiMA mixes are expected to retard reflective cracking, resist low temperature cracking up to an estimated temperature of approximately -28 °C, and show minimal rutting and moisture damage in the field.

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**Figure 4: Results Summary from Testing the HiMA Mixtures Placed in Minnesota (MN), New Hampshire (NH), and Vermont (VT)**

<table>
<thead>
<tr>
<th>Mixture</th>
<th>Average OT Cycles to 93% Load Reduction</th>
<th>Average TSRST Failure Temperature</th>
<th>Average Rut Depth from APA after 8,000 Cycles</th>
<th>HWTD – Stripping Inflection Point</th>
</tr>
</thead>
<tbody>
<tr>
<td>MN HiMA Mixture</td>
<td>434</td>
<td>-31.8 °C</td>
<td>5.92 mm</td>
<td>16,700</td>
</tr>
<tr>
<td>MN Control (No Polymer)</td>
<td>133</td>
<td>-32.2 °C</td>
<td>6.20 mm</td>
<td>14,600</td>
</tr>
<tr>
<td>NH HiMA Mixture</td>
<td>2,000*</td>
<td>-33.1 °C</td>
<td>5.16 mm</td>
<td>10,000</td>
</tr>
<tr>
<td>VT HiMA Mixture</td>
<td>2,000*</td>
<td>-30.1 °C</td>
<td>2.03 mm</td>
<td>10,000</td>
</tr>
<tr>
<td>VT HiMA Mixture + 24% RAP</td>
<td>1,144</td>
<td>-27.8 °C</td>
<td>2.87 mm</td>
<td>NONE</td>
</tr>
</tbody>
</table>

* Mixture did not reach failure criteria at the conclusion of 2,000 cycles in the OT device.
Emulsions

Based on the data generated on structural HiMA mix test sections at NCAT as well as during the AASHTO TSP2 program for highly polymer-modified thin mix surfacings, this technology platform was translated for potential use in highly pre-modified micro surfacing emulsion surface treatments.

In the case of highly pre-modified micro surfacing emulsions, a balance between ease of emulsification and polymer loading level must be maintained. In the case of the HiMA polymer option, it was determined that 6 wt% loading level in the micro-emulsion base asphalt provided this balance. The polymer network becomes continuous in most bitumens in the 6-8 wt% range. Emulsification can be achieved easily at typical micro surfacing emulsion residue contents primarily due to the low viscosity imparted by the Kraton® D0243 polymer.

Additionally, the low viscosity of HiMA particle droplet leads to ease of coalescence of the HiMA residue upon application with concurrent reformation of the polymer network in place.

Kraton Polymers’ HiMA formulations allow durable asphalt pavement with a reduced pavement thickness that lowers costs thus permitting larger resurfacing opportunities within fixed budgets. HiMA technology enables the installation of roads that last longer and require less maintenance. Our goal is to make pavements more cost-effective. HiMA formulations allow for higher polymer loading in the mix to achieve up to a 50% reduction in asphalt thickness.

Improved resistance to thermal cracking and reflective crack propagation is hoped to be achieved in the field, as well as resistance to shoving from high load vehicles, especially when turning at intersections or in residential streets.

Additionally, in order to maximize the durability and fatigue resistance of the micro surfacing mat in-place, a one grade softer binder is incorporated with the HiMA polymer in these highly pre-modified emulsion formulations. Since the softening point of the HiMA emulsion residue can be up to 15-20 °C (30-40 °F) higher than a conventional latex-modified micro surfacing emulsion residue, resistance to flushing is improved.

Particle size and particle size distribution are typical of that seen with a conventional latex-modified micro surfacing emulsion using a harder, unmodified bitumen. Additionally, ISSA A143 micro surfacing mix properties such as wet track abrasion are equivalent or better than reference latex-modified micro surfacing emulsion systems.

**Figure 5: Control + HiMA Micro Surfacing Emulsion SP and WTAT (Wet Track Abrasion Test) Results**

<table>
<thead>
<tr>
<th>Emulsion ID</th>
<th>ASTM D36</th>
<th>ISSA TB 100</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>SP (°C) / SP (°F)</td>
<td>1 Hour</td>
</tr>
<tr>
<td>Control</td>
<td>62 / 144</td>
<td>293 / 27.2</td>
</tr>
<tr>
<td>HiMA</td>
<td>83 / 181</td>
<td>95 / 8.8</td>
</tr>
</tbody>
</table>

**Figure 6: Control + HiMA Micro Surfacing Emulsion Particle Size Distribution**
We Welcome the Opportunity
to answer your questions and help find the best solution for your pavement requirements.

Please visit www.pavewithkraton.com
or contact at +1-800-4-KRATON (572866) for more information about this new technology solution.
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Kraton Corporation (NYSE: KRA) is a leading global producer of styrenic block copolymers, specialty polymers and high-value performance products derived from pine wood pulping co-products. Kraton’s polymers are used in a wide range of applications, including adhesives, coatings, consumer and personal care products, sealants and lubricants, and medical, packaging, automotive, paving and roofing applications. As the largest global provider in the pine chemicals industry, the company’s pine-based specialty products are sold into adhesive, road and construction, and tire markets, and it produces and sells a broad range of performance chemicals into markets that include fuel additives, oilfield chemicals, coatings, metalworking fluids, and lubricants, inks and mining. Kraton offers its products to a diverse customer base in numerous countries worldwide.

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- Offices
- Manufacturing - Chemical Segment
- Manufacturing - Polymer Segment

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