

# HIGHLY MODIFIED EMULSIONS FOR MICRO SURFACING

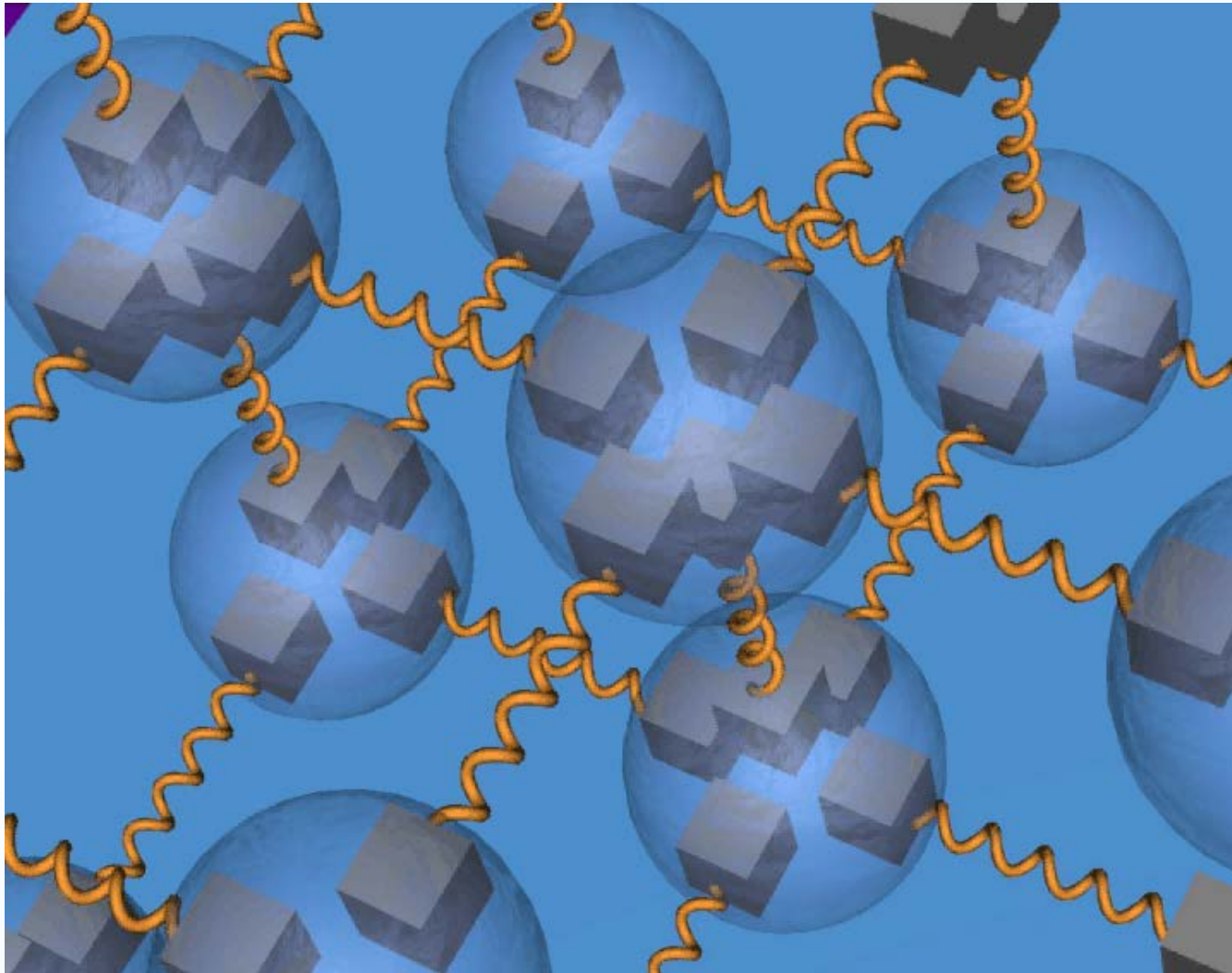
15<sup>th</sup> Annual AMAP Meeting

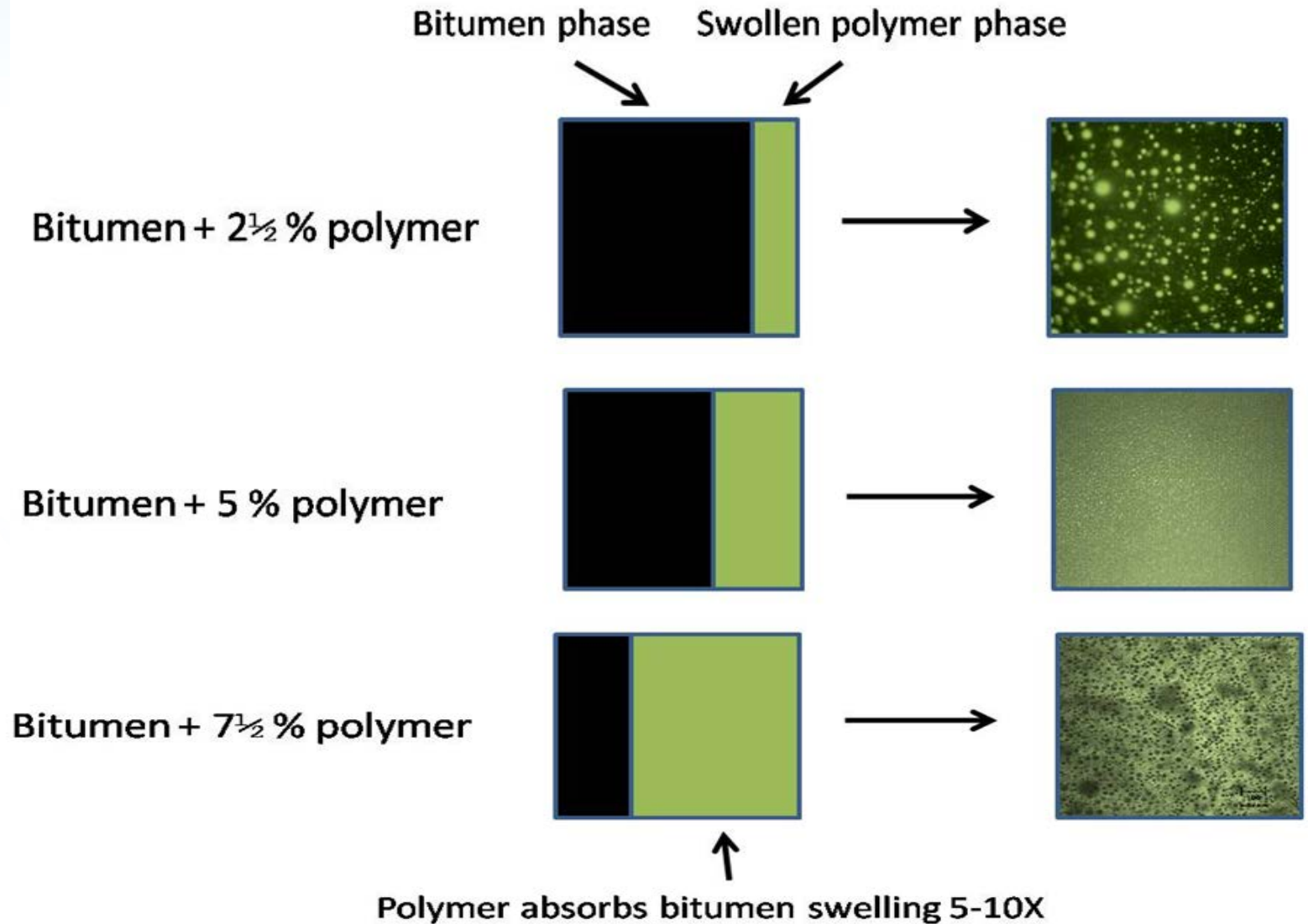
New Orleans, Louisiana, February 20, 2014

Chris Lubbers, Kraton Polymers, LLC



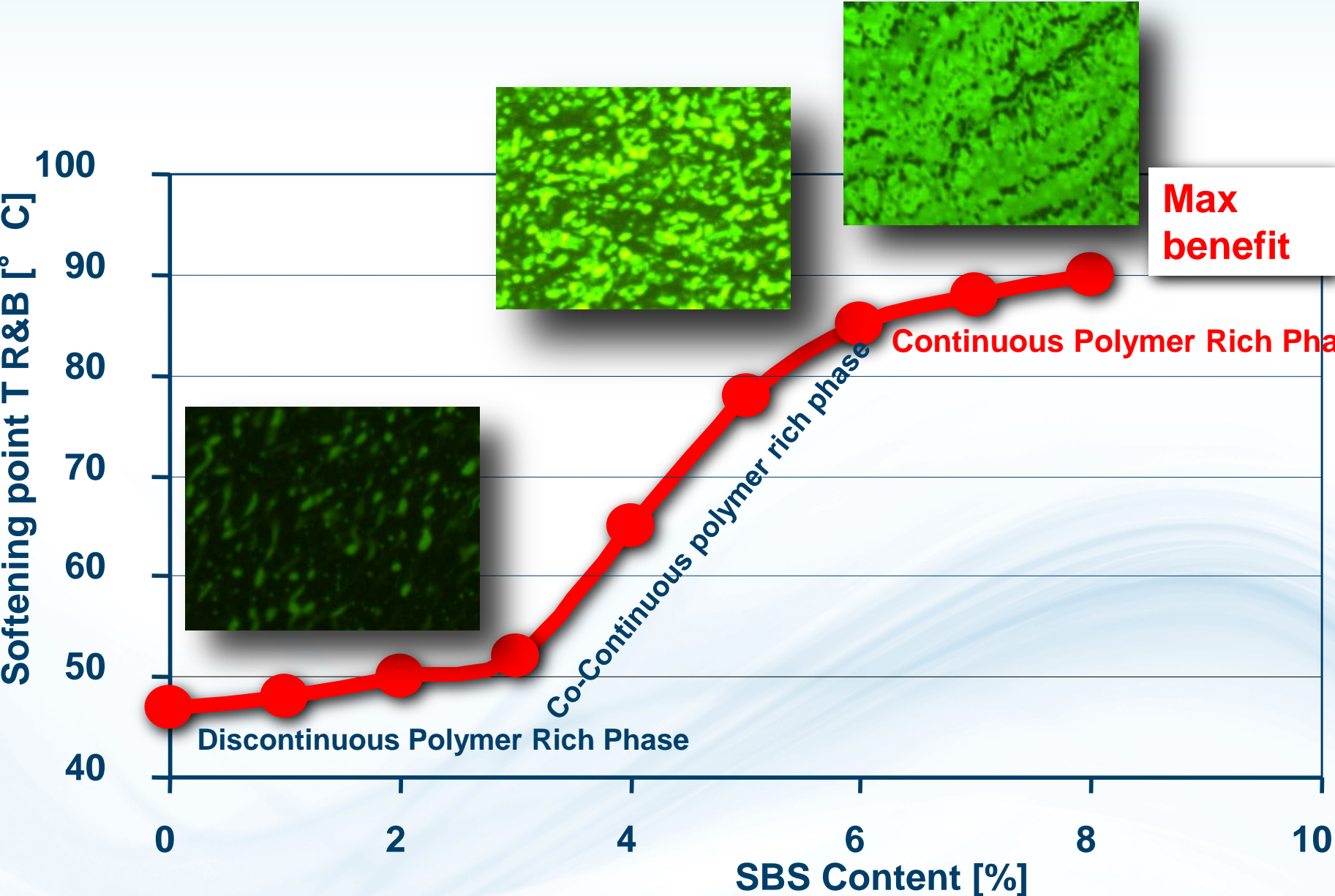
- How SBS Works in Bitumen
- Background of the Highly-Modified (HiMA) Binder Concept
- Highly-Modified Emulsions for Micro Surfacing



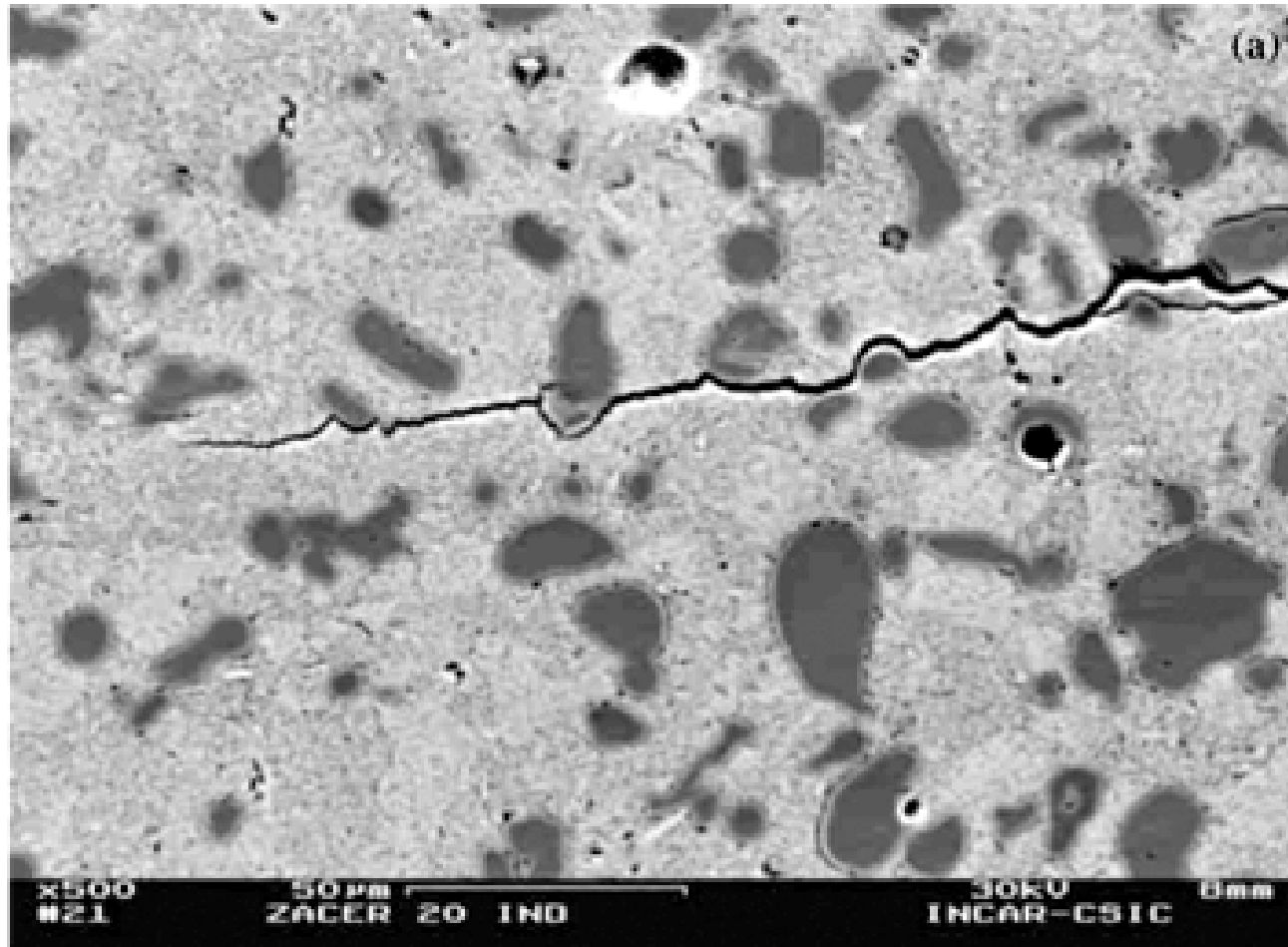




# HiMA Binders - Asphalt - Modified Polymer




# Crack Propagation in Toughened Composite

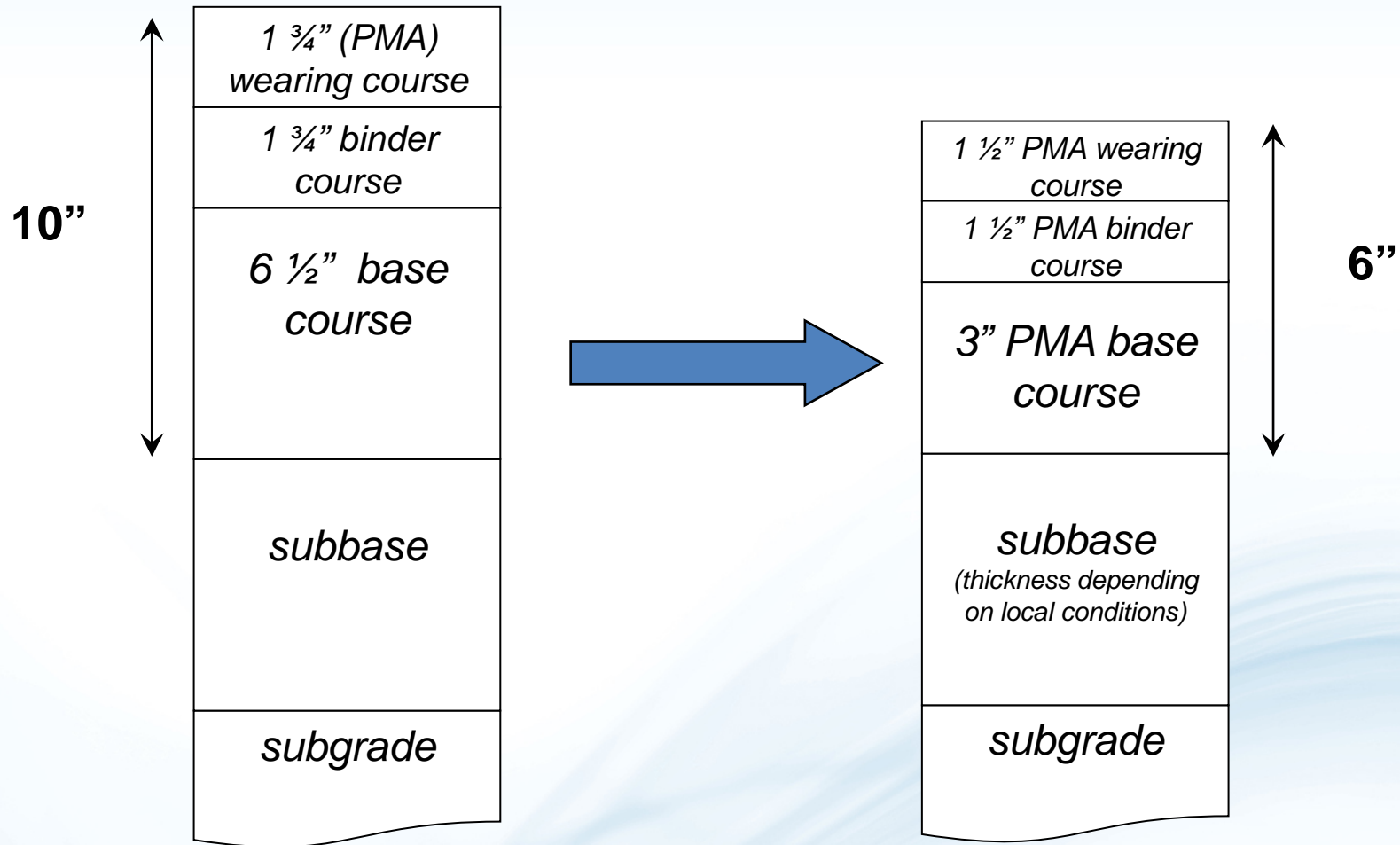


S. López-Esteban, J.F. Bartolemé, C. Percharromán, S.R.H. Mello Castanho, J.S. Moya, *Wet Processing and Characterization of  $ZrO_2$ /Stainless Steel Composites: Electrical and Mechanical Performance*, Materials Research, Vol. 4, São Carlos, July 2001. Used with permission.

- Higher traffic intensities and pavement loadings require more durable pavements.
- Higher traffic intensities also command longer maintenance intervals to increase availability of the road.
- Environmental pressure is increasing; reduction of use of natural resources such as aggregate and less emissions are highly desired.
- SBS modification has proven benefits in wearing courses over the past decades in every relevant property.

 Use the benefits of SBS to create a polymer modified base course, intermediate course, and/or wearing course at reduced thickness - individual layer or composite pavement design

# Proposed System Redesign



**Conventional**

**HiMA**

This is an example; depending on local conditions other types may apply



- Highly Modified Asphalt is a tool. It can be used to improve performance and cost effectiveness in a variety of asphalt paving applications:
- New construction and structural rehabilitation - thinner structures, lower upfront cost.
- Preservation overlays - thinner structures, more resistant to thermal and reflective cracking. (AASHTO TSP2 program)
- Micro surfacing - more resistant to cracking and raveling
- Open grade mixes - more resistant to raveling. Resistant to drain down (no need for fibers)
- Waterproof bridge decks - zero void mixes that are rut resistant and yet highly flexible
- Etc.

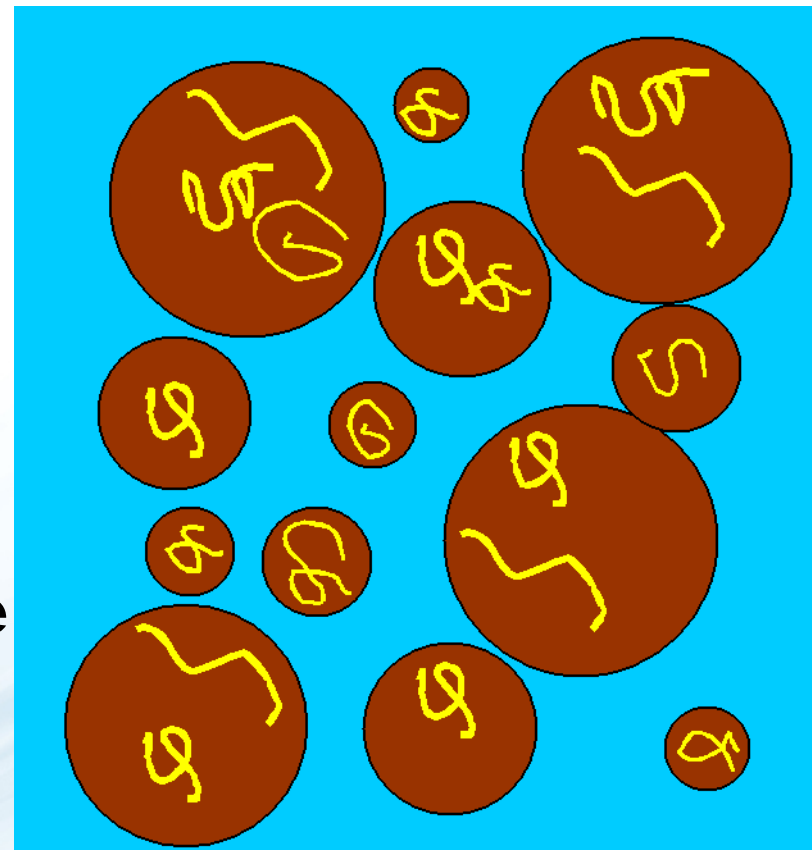
- Federal, state, and local agency budgets shrinking
  - Recession, loss of tax revenues, limited long-term surface trans. bill
- Balance of power shift at FHWA in Washington, DC and state offices
  - To – preservation/asset management functions
  - Away from – materials/construction/engineering functions
- Move to preserve existing infrastructure using non-structural pavements
  - More cost-effective initially and in long-term (LCCA)
- Asphalt emulsion usage level by state agencies today - 10% of total budget
  - Predicted to move to 20-30% of total budget in next few years

## Polymer Modification of Asphalt Emulsions – SB/S

- Emulsify polymer modified asphalt

- “Pre-modified” emulsion
- Polymers – SBS, SB-
- Higher mod. asphalt viscosity
  - Higher asphalt + mill temp.
- Exit temp. > 100°C
- Heat exchanger, back pressure

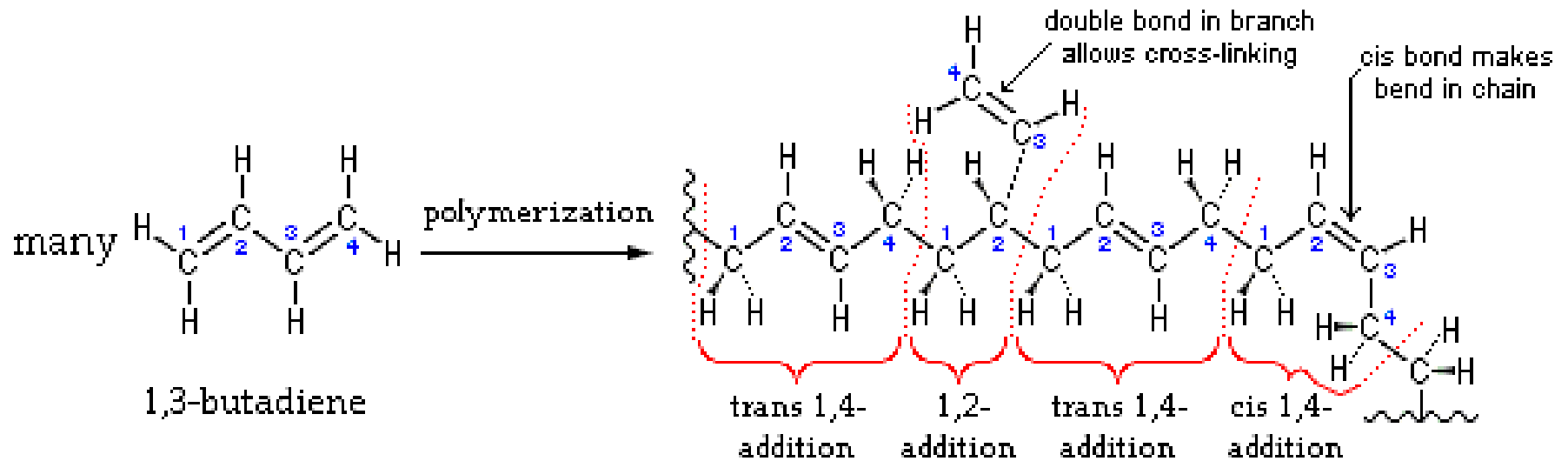
- Polymer inside asphalt droplet



# High Vinyl Butadiene SB/S Technology



- Butadiene monomer addition via 1,2 vs 1,4 polymerization
- Results in smaller effective molecular volume for same MW
- Thermal reactivity of 1,2 vinyl Bd pendant groups



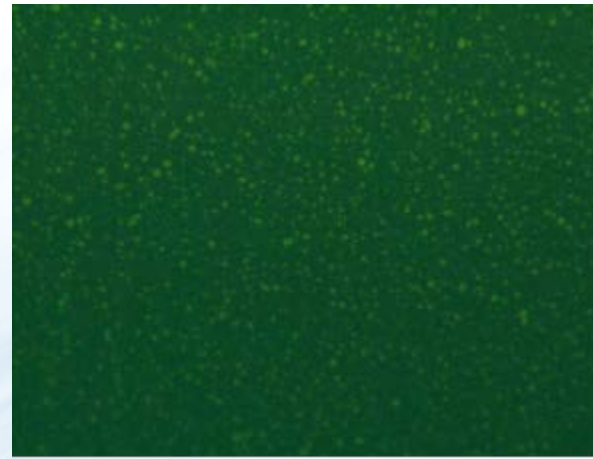
# Pre-Modified Asphalt Props. - Chip Seal



- Base asphalt - PG 52-34/200 dmm PEN
  - Calumet Specialty Refining, LLC - Superior, WI
  - 3 wt% dry polymer loading on asphalt
  - Vs conventional linear SBS
- Improved compatibility - HV SB/S vs Linear SBS

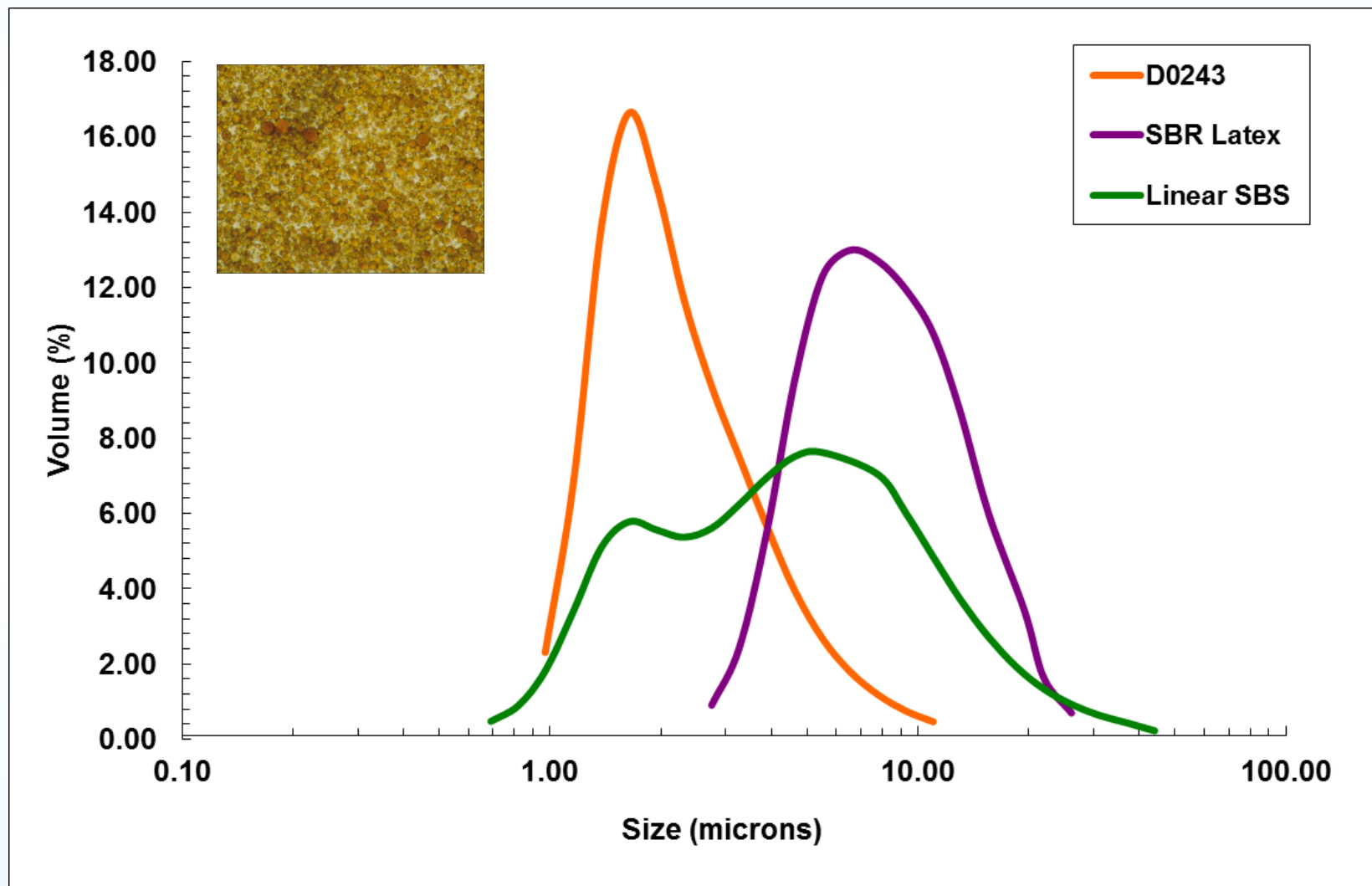


HV SB/S Dispersion

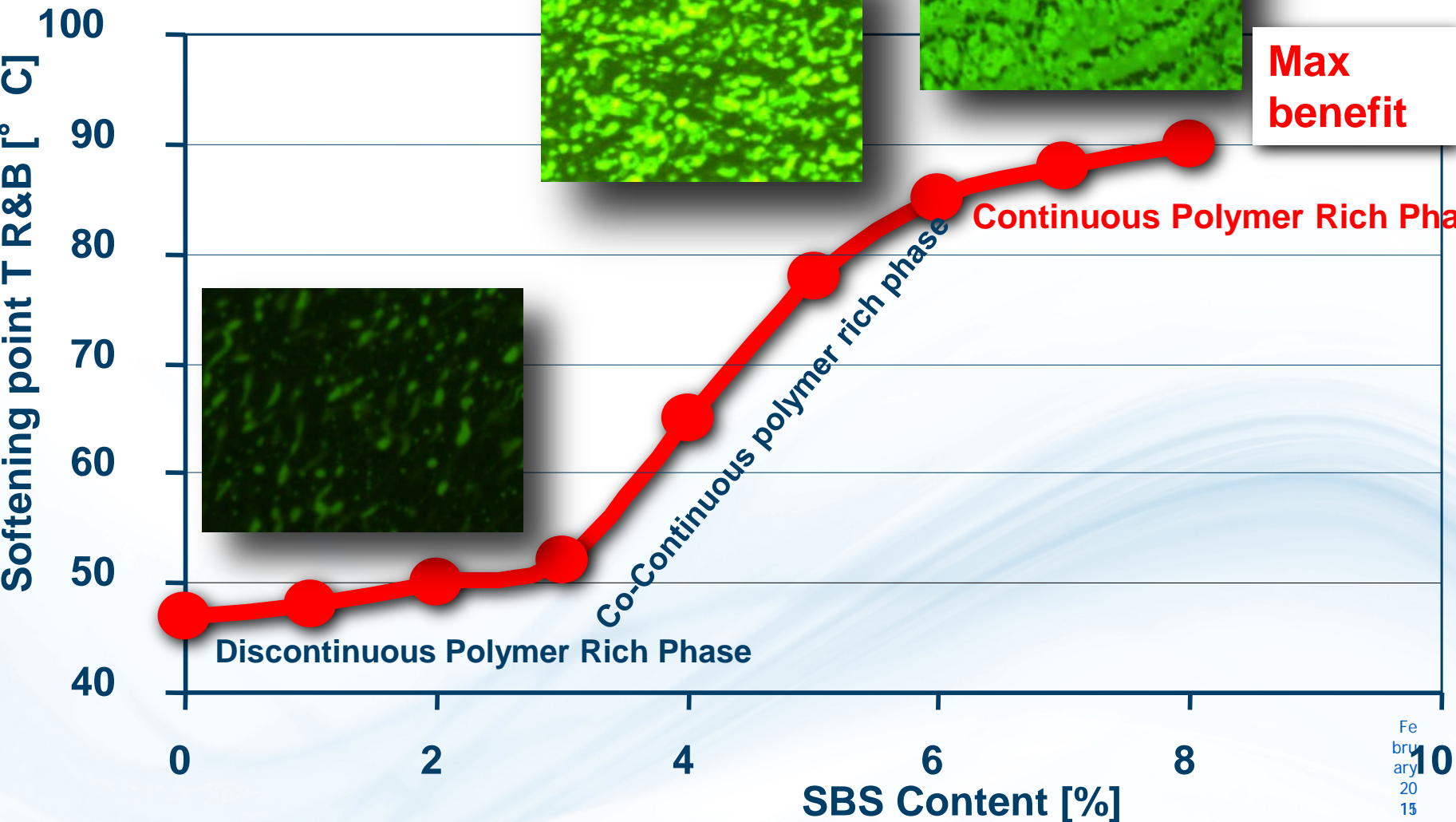


Linear SBS Dispersion





# HiMA Micro Surfacing – 6 wt% Loading Level



# MN HiMA Micro Surfacing Job Story



**INSIDE**

Site-K  
Construction Zone



Industry News  
page 6



New Advances in  
Planning a Bore  
page 19



Also in this issue

- Rock Drilling Technology
- Tough Enough
- Asset Management
- Knowledge Management

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Edition

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## MNDOT FURTHERS PAVEMENT MICRO SURFACING RESEARCH

*Agency's District 3 tries new highly polymer modified asphalt emulsion in demonstration on section of Trunk Highway 23 near St. Cloud*

By Paul Fournier

Minnesota's Department of Transportation continues its practical research of pavement preservation techniques with the recent demonstration of micro surfacing containing emulsified highly polymer modified asphalt (HiMA) on a section of Trunk Highway 23.

ASTECH Corporation of St. Joseph, Minn., applied the micro surfacing on a one-mile section of the two-lane highway near the city of St. Cloud, the county seat of Stearns County and the largest population center in the state's central region. Bisected by the Mississippi River, St. Cloud is a regional transportation hub in Minnesota, with major roadways including Interstate Highway 94, U.S. Highway 10, and Minnesota State Highways (Trunk Highways) 15 and 23 passing through the municipality.

Located about 65 miles northwest of Minneapolis-St. Paul, the city of St. Cloud lies within MnDOT's District 3, which has the largest population base outside of the Twin Cities metropolitan area. District 3 encompasses all or part of 14 counties, and its personnel plan, design, construct and maintain roughly 1,650 centerline miles (nearly 4000 lane miles) of Interstate, U.S. and trunk highways.

### Sophisticated Pavement Research

The June 2012 TH23 application was the first time MnDOT used HiMA emulsion in the micro surfacing process, although the agency did approve the installation of hot mix asphalt modified with HiMA on a section of TH100 west of Minneapolis last year, as part of its continuing search for advanced products capable of retarding pavement reflection cracks.

Minnesota's trunk highway system of 11,000 miles ranks it the fifth largest in the nation, and its DOT is considered to be in the forefront of highway maintenance, research and construction practices. In connection with this, the agency owns and operates MnROAD, a sophisticated pavement test track built to study various research materials and pavements. MnROAD works in conjunction with MnDOT's Materials Lab located in Maplewood, Minn. (See sidebar on last page.)

Jerry Geib, MnDOT research operations engineer, suggested the use of HiMA in the 2011 TH100 mill-and-fill hot mix asphalt operation. That application went without incident, with the paving crew noting there was no difference between handling HiMA mix and MnDOT's usual 12.5mm Superpave mix. The asphalt binder used in this mix was dosed at 7.5-percent SBS polymer.



*ASTECH Corporation applies micro surfacing containing emulsified highly polymer modified asphalt to a section of Trunk Highway 23 for Minnesota DOT.*

- **Emulsion producer - Flint Hills Resources - Wichita, KS**
  - 6 wt% D0243 in PG xx-34 base AC - >200 dmm PEN
    - SP - 156°F
    - PEN - 122 dmm at 25C
  - Control - 3.5 dry wt% cationic SBR latex in PG 64-22 base AC
  - Two trial sections
    - MN Road Cell #1 - Interstate 94 - **16 wt% emulsion** with no control
    - ADT - 28,000 vehicles/day including heavy truck traffic
    - TH 23 - **13 wt% emulsion** with control
    - ADT - >5000 vehicles/day
    - PCC slab (original) + 6 in. of bit. concrete ('98) + chip seal ('04)
- **Contractor - ASTECH Corporation - St. Joseph, MN**
  - Leveling course and surface course applied to trial sections
  - Type II gradation
  - Application rate - net 30 lbs/yd<sup>2</sup>



# HiMA Micro Emulsion Application

## Mn Road Cell #1 - Before/After - 6/2012



### Before

Passing Lane - PG 58-28 Asphalt Concrete - 12 yrs old over BC

Slow Lane - PG xx-34 Asphalt Concrete - 6 yrs old over BC



# MO HiMA Micro Surfacing Job Story



**INSIDE**

Site-K Construction Zone page 1

**SITE-K CONSTRUCTION ZONE**

Industry News page 7

**Market Forecast** page 15

**Association News** page 47

**Also in this Issue:**

- Trends That Will Innovate
- FMI Regional Summaries
- Important Pavement Data
- Tweel - Michelin Rolls Out New Tire Technology

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**MIDWEST CONTRACTOR** Edition

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**MISSOURI CITY SEEKS TOUGHER CUL-DE-SAC PAVEMENTS**

*Lee's Summit tries highly modified asphalt micro surfacing to counter damaging wheel loads of trash trucks*

By Paul Fournier

Missouri's sixth largest city is testing a new type of micro surfacing in hopes it will better resist wheel loads of heavy trash trucks that damage pavement surfaces in the community's many cul-de-sacs.

Lee's Summit, a city of 91,000 people located in Jackson and Cass Counties in the western part of the state, approved the use of micro surfacing made with highly polymer modified asphalt emulsion for 20 cul-de-sacs in an upscale residential area abutting scenic Raintree Lake.

The city's pavement management program, financed by a 1/2-cent transportation tax, utilizes a number of scheduled programs to maintain or restore paved road surfaces including its annual micro surfacing contract. Vance Brothers, based in Kansas City, Mo., which has this year's micro surfacing contract, was asked if they could produce a tougher pavement treatment for the cul-de-sacs.

"The city has been looking but so far hasn't found anything to use in these cul-de-sacs," said Howie Snyder, Slurry/Micro Surfacing operations manager for Vance Brothers. Snyder said their contract includes not only cul-de-sacs but major thoroughfares and residential streets as well. He noted that conventional micro surfacing performs well on streets but not on cul-de-sacs, especially those in the Raintree Lake area, where unusually heavy truck traffic damages the pavement surface treatment.

"A number of private companies provide trash pickup for residents in this area, so on any one day, you could have 2- to 5 trucks with

40,000-pound front-axes going around the cul-de-sacs," he said.

Conventional micro surfacing has failed to withstand the tremendous pressure of turning tires that knead and smear the surface treatment. What's more, the higher than normal temperatures plaguing the Mid-West this year have exacerbated these detrimental effects.

**Micro Surfacing Benefits and Limits**

Micro surfacing, a pavement preservation method, is used to extend the life of existing, structurally sound asphalt pavements. It is a cold-mix material, made on site by a continuous mix paver that combines mineral aggregate (usually #4 minus), Portland cement or other type of mineral filler, and a polymer-modified asphalt emulsion. Capable of being spread in different thicknesses, micro surfacing can be used as a leveling or scratch course, to fill pavement wheel ruts, or placed as a thin wearing course, or seal, to protect the underlying pavement.

*Vance Brothers' Bergkamp continuous mix paver applies micro surfacing made with highly polymer modified asphalt emulsion in Lee's Summit, Mo.*

# MO HiMA Micro Surfacing Project - 7/2012

- **Emulsion producer - Vance Brothers - Kansas City, MO**
  - 6 wt% D0243 in PG 58-28 base AC
    - SP - 180+°F, PEN - 65-70 dmm at 25C
  - Control - 3.0-3.5 dry wt% cationic SBR latex in PG 64-22 base AC
    - SP - 140+°F, PEN - 40-90 dmm at 25C
  - Trial sections - 13 wt% emulsion
    - 20 cul-de-sacs in Lee's Summit, MO - suburb of Kansas City, MO
    - Residential neighborhood, BUT
      - Two to five, 40,000 lb front-axle trash trucks per day
      - Control micro surfacing mat failed
- **Contractor - Vance Brothers - Kansas City, MO**
  - Single course applied
  - Type II gradation
    - HiMA - Limestone aggregate
    - Control - Granite aggregate
  - Application rate - 24-25 lbs/yd<sup>2</sup>



# HiMA Micro Emulsion Application Cul-de-Sac - Lee's Summit, MO - 7/2012



- Ergon/Viking - Dallas, TX - 9/2012 (PG 58-28)
- Ergon/Sealcoating - Hingham, MA - 10/12 (PG 58-28)
- Ergon/Sealcoating - Dartmouth, MA - 8/13 (PG 58-28)
- Ergon/Sealcoating - Northbridge, MA - 9/13 (PG 58-28)
- Ergon/APS - PENN DOT - Lancaster, PA - 9/13 (PG 58-28)
- Ergon/APS - Lakeland, FL - 9/13 (PG 58-28)
- Ergon - Utah - 10/13 (PG 58-28)

# HiMA Micro Surfacing Projects

## Field Observations



- HiMA emulsion handled/applied/cured ~ control systems
  - No special requirements for storage/handling/application
- Initial durability/toughness of HiMA mat >> control systems
- Resistance to reflective cracking ~ control systems



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