Emerging Products and Technologies

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Asphalt Pavements Materials Conference
Workshop on Understanding Modified Binder Technology *April 10, 2014*

Outline

- Objective
- Formative concepts
- Products
  - Warm mix asphalt
  - Pelletized asphalt
  - Polymeric and rubber products
  - Layered silicates
  - Biologically derived modifiers and replacements
- Summary

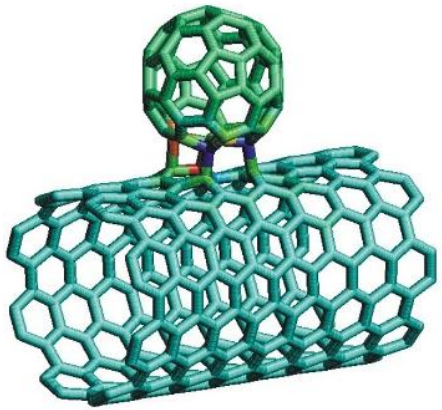
Objectives

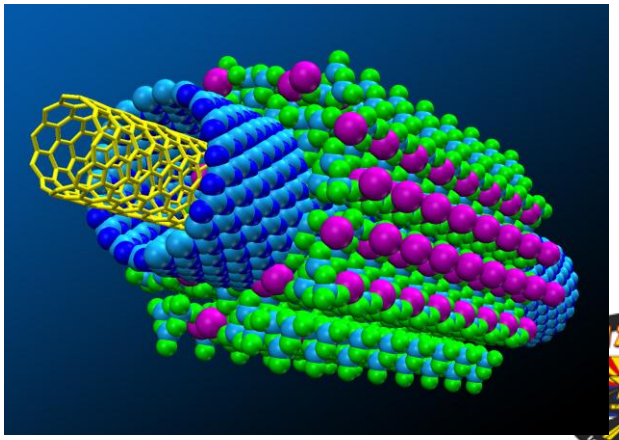
- Introduce materials and techniques that are being introduced or studied for near term use in asphalt concrete applications.
- Specific outcomes
  - Explain the forces that exist, which drive the need for evolving technologies.
  - List 5 different emerging material types

part I: concepts that drive material development

Formative Concepts

- Materials by design (20…30…100 years)
  - Materials can be engineered to behave in desirable ways.
  - Limits of material have thus far been limited by our creativity.
  - 20…30….100 years into the future before realization.





Formative Concepts

- Purposed materials (engineering practice)
  - Materials or methods are discovered and their properties are determined.
  - Materials/methods are deployed to solve problems.
  - Material decisions become strategic part of structural design and infrastructure performance
  - **Right materials right application**


wiseGEEK

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part II: products

Warm Mix Asphalt

Chemical Modification (additive based)

- Evotherm*
- Sasobit*
- Advera*
- Aspha-Min
- Thiopave
- Rediset
- Others…

Physical Modification (foaming based)

- AQUABlack*
- Evergreen Double Barrel Green
- EcoFoam
- Zeolite
- Others…

It is estimated by some that the term warm mix asphalt concrete will disappear in 3-5 years because all asphalt concrete mixtures will be made with these technologies.

Warm Mix Asphalt Use

- Reduce mixing and discharge temperatures
  - Reduced aging
  - Reduced emissions
  - Potential for increased moisture content
- Compaction aid
  - Keep temperatures the same and add to improve compaction or maintain workability under long haul distances.

Warm Mix Asphalt

- National efforts to identify practices and performance
  - NCHRP 9-43: Mix Design for WMA (**Complete**)
  - NCHRP 9-47 and 9-47A: Engineering Properties, Emissions, and Field Performance of WMA Technologies (**Complete**)
  - NCHRP 9-49: Performance of WMA Technologies: Stage I – Moisture Susceptibility (**Complete**)
  - NCHRP 9-49A: Performance of WMA Technologies: Stage II – Long-Term Field Performance (**Ongoing**)
  - NCHRP 9-53: Properties of Foamed Asphalt for Warm Mix Asphalt Applications (**Ongoing**)

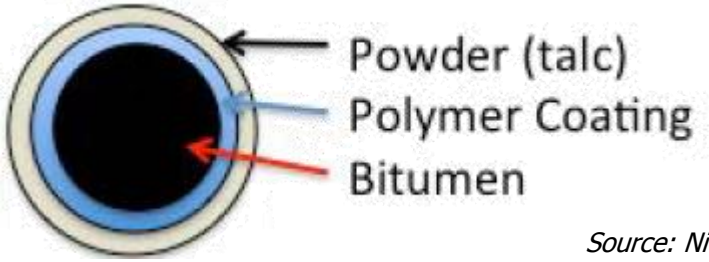
Pelletized Asphalt Systems

RMUPG White Paper

- Delivery method to distribute a stable product irrespective of modification technology that can be created centrally and transported in bulk without specialized requirements.
  - Applicable to polymers, rubber, fibers, anti-strip chemicals, etc.

Use of Pelletized Asphalt Systems

- Asphalt binder is formulated and pelletized at a central location.
- Pellets are transported in bulk at ambient temperatures.
- Can be introduced as normal aggregate or RAP stockpiles with or without additional liquid.



Source: NiTech

Source: RMUPG

Source: Billian

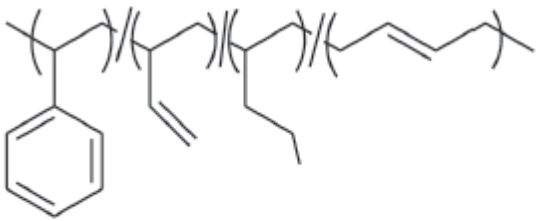
Potential Benefits of Pelletized Asphalt

- On-demand, quality materials where large and consistent volumes of mixture are not needed.
- Expanded use of hybrid modification.
  - GTR+SBS or waste polymers
  - Higher RAP percentages at a wider range of locations

Functionalized Polymer Systems

- Chemical modification of polymeric additives to obtain targeted benefits beyond those seen from the primary polymer.
  - Better stability
  - Balanced high and low temperature properties
  - Improved aggregate adhesion

SBR



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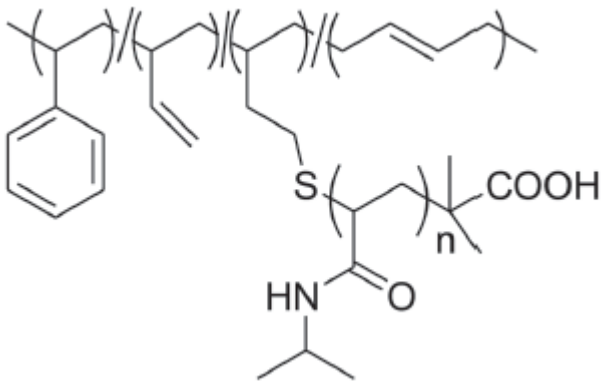
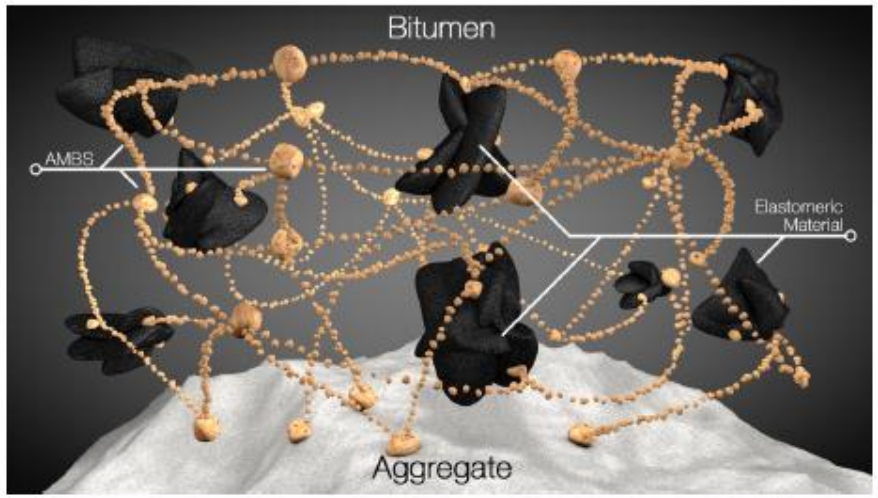


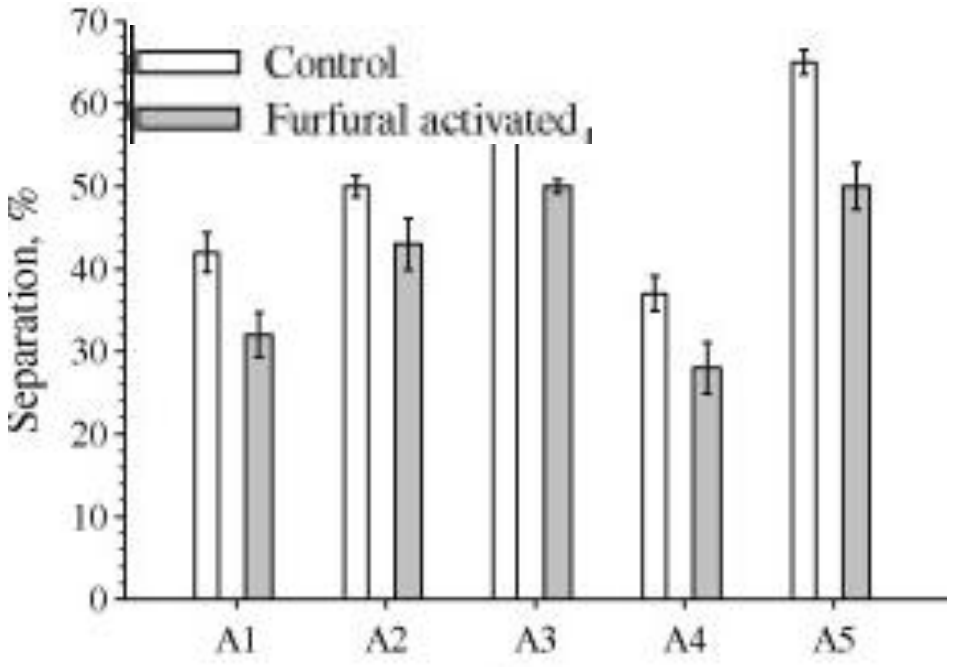
Activated Rubber Systems

- Activated materials have surfaces that perform some function
  - Example: activated charcoal
- Rubber surface is activated along with other modifications to improve the engineering properties.



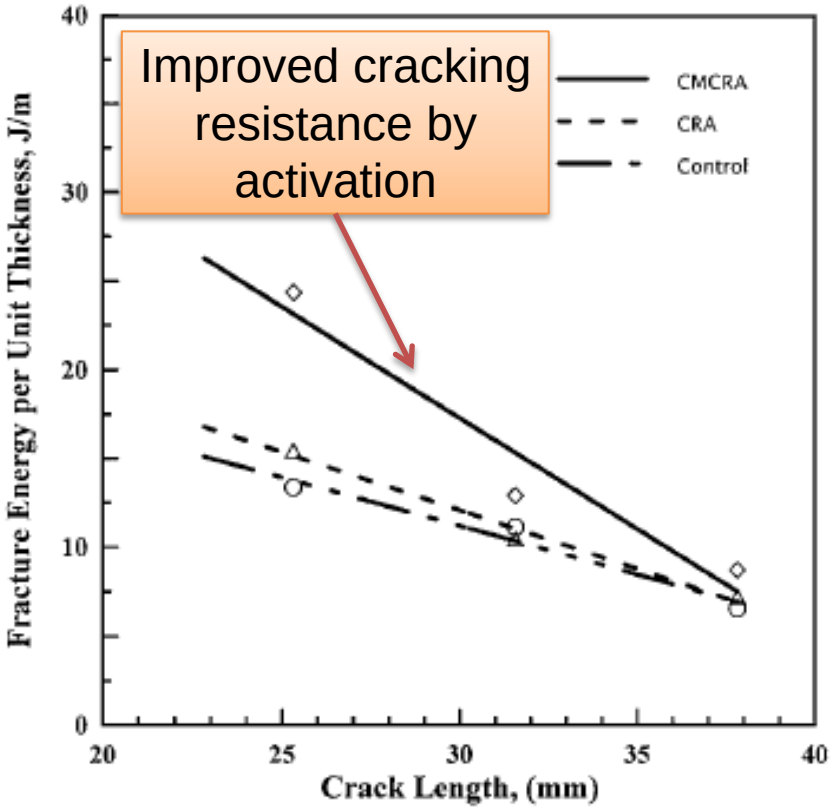
Activated Rubber Systems

Phase Separation



Source: Shatanawi et al. 2012

Cracking Resistance



Source: Mull et al. 2002

Reactive Polymer/Rubber Blends

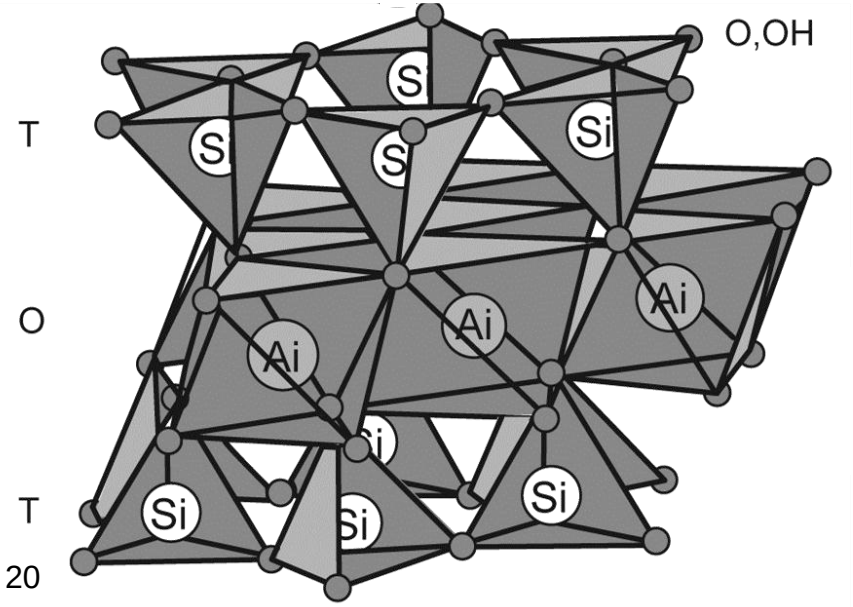
- Reactive processes induce chemical changes during melt.
- Polymer initially reacts with elements in asphalt to lower the viscosity and facilitate blending.
- As chemical reaction continues the viscosity will increase and prevent separation of the rubber particles.

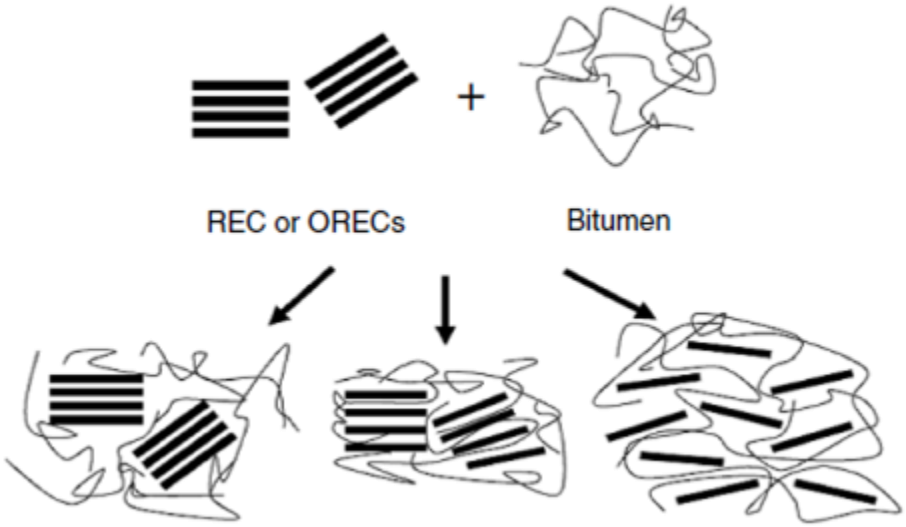

Source: Puga 2013


Source: Carlson

Layered Silicates

- Layered silicates are also known as nanoclays.
  - Examples: Montmorillonite, Rectorite, Vermiculite, and Kaolinite clay





Zhang et al. 2013

Concept of nanoclay modified materials evolved from the polymer industry where these products have desirable engineering properties

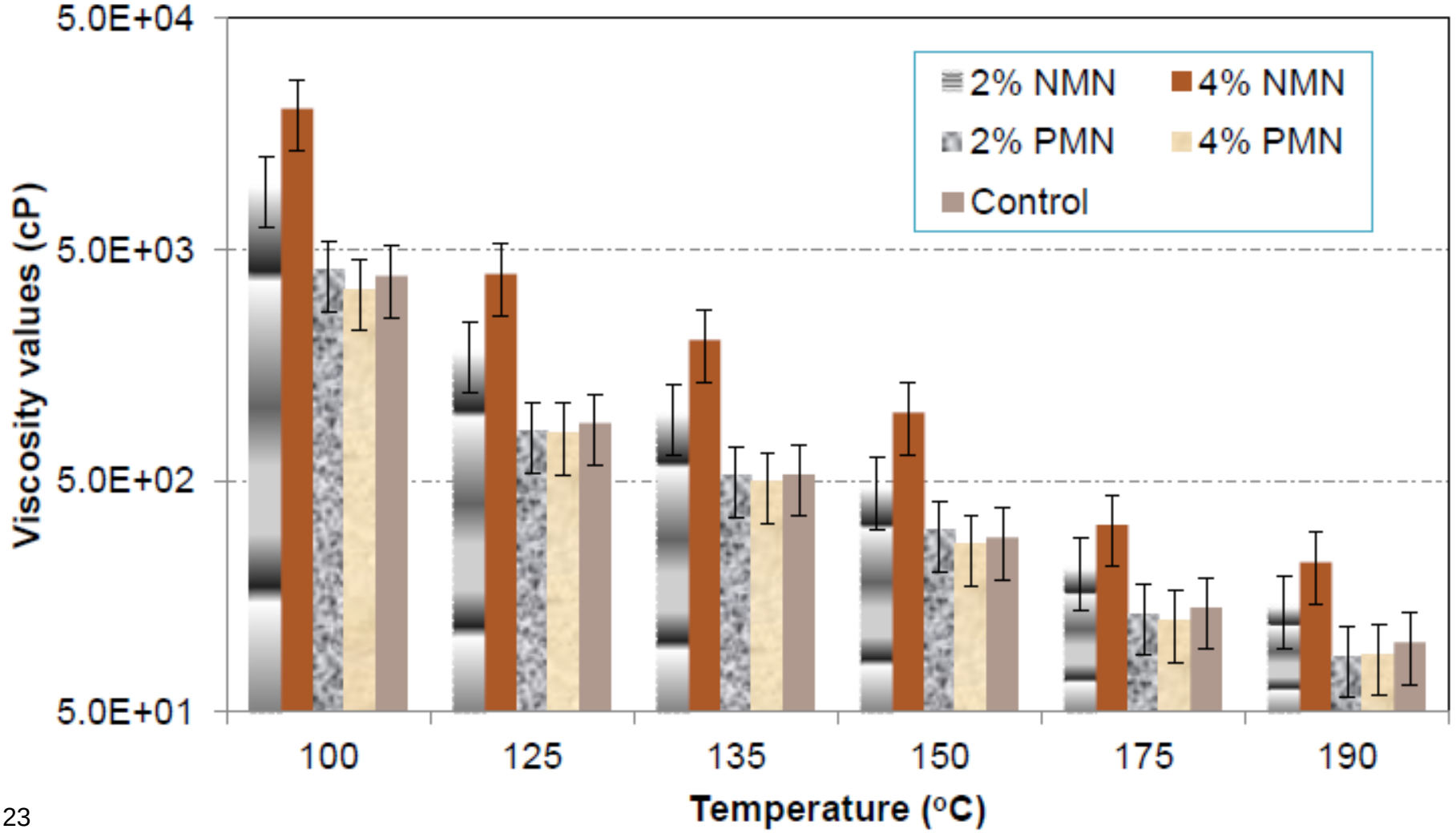
Source: Alan James and Peter Zhou AkzoNobel

Layered Silicates

- Functions
  - Increase stiffness of asphalt binder
  - Improve aging resistance by introducing oxidation barriers
  - Improve storage stability of polymer modified asphalts

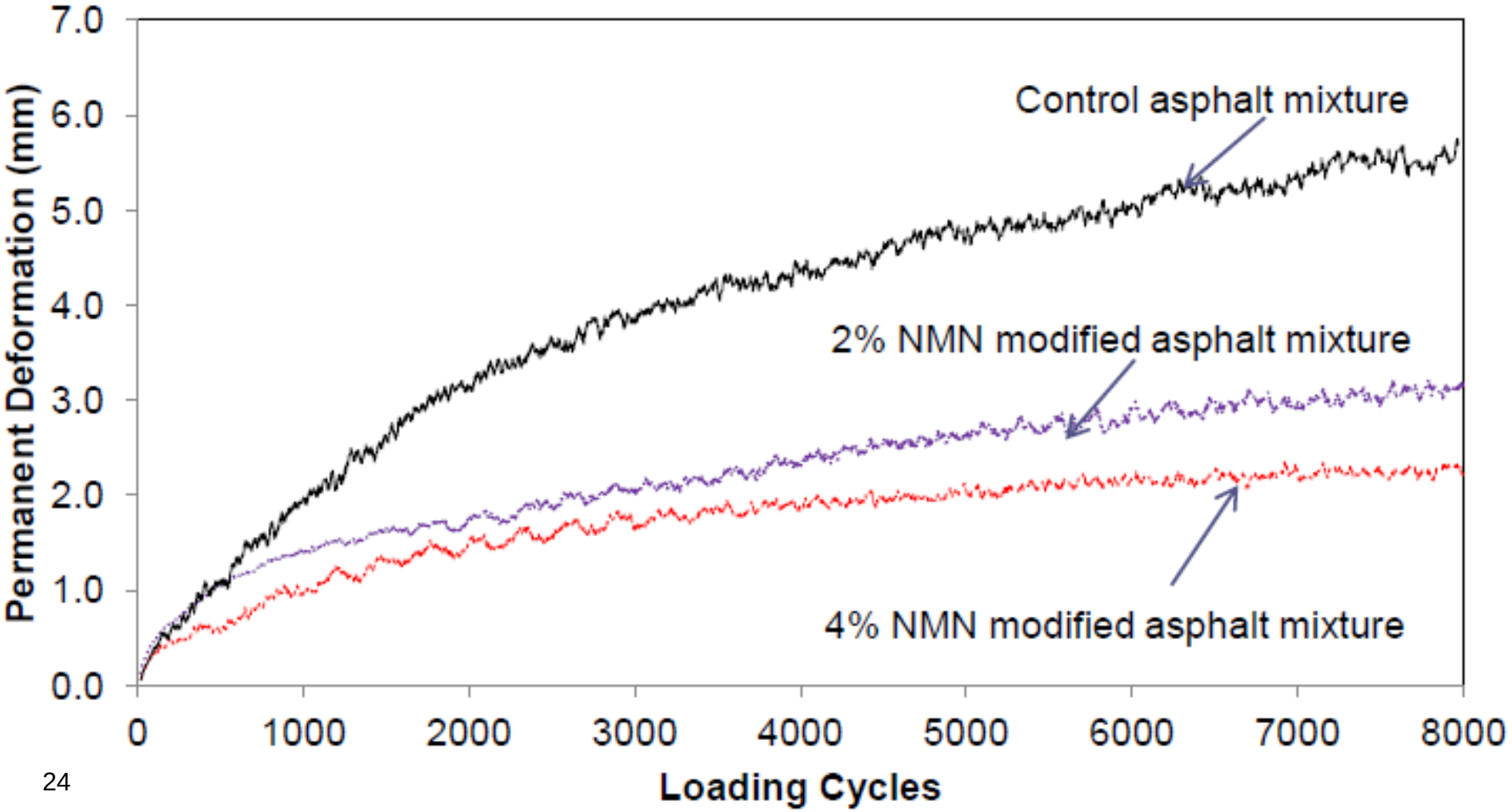
Effect of Nanoclay on Binder Properties

You et al., Michigan Technological University



Effect of Nanoclay on Mixture Properties

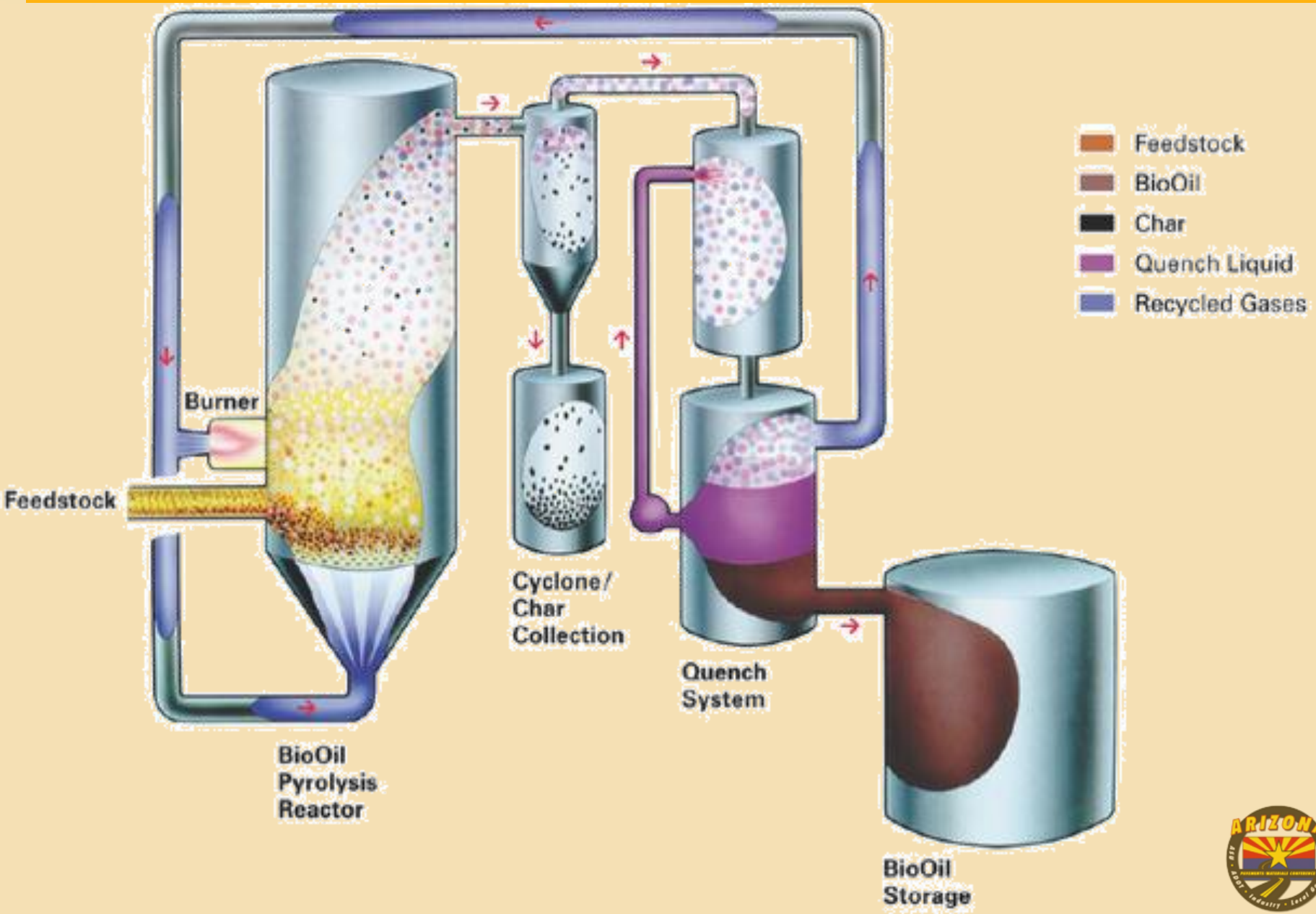
You et al., Michigan Technological University



Biologically Derived Products

- Biologically derived products are refined from oils that come from a biomass feedstock.
  - Fermentation
  - Pyrolysis
  - Gasification
- Uses
  - Direct replacement for asphalt
  - Extender and rejuvenator

Bioasphalt is a material derived from the production of oil from recently living biological materials (bio-oil)



Sources of biomass can vary and many options are being evaluated on a regional basis.

Biologically Derived Products

- Issues
  - Scale of production.
  - Engineering properties and relationship to processing techniques.
  - Identification of sources that do not compete for land and water resources now used for food production.
  - Aesthetic – coloration and smell

Wrap-up

- Why is continued material development important?
  - There is a need to deliver high quality, long lasting, and well performing materials under specific constraints.
  - Findings and theories in other materials related disciplines suggest that we have not yet reached the maximum potential benefits from paving materials.

Wrap-up

- What are some emerging material types/subtypes?
  - Warm mix asphalt additives
  - Pelletized asphalt systems
  - Functionalized, activated, and reactivated polymer and polymer-rubber systems
  - Layered silicates
  - Biologically derived modifiers and replacements

Thank you

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