



Portfolio of Bio-Based Functional Resins and Thermoset Materials

NDSU Research Foundation

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Technology Manager/Patent Agent

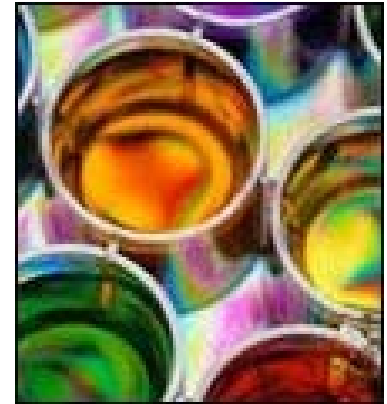
First Presented at

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June 14, 2011

Background

- Department of Coatings and Polymeric Materials at North Dakota State Univ. (NDSU)
 - Is internationally renowned
 - The oldest of only three such departments in the world
 - The only academic research focused on polymer organic coatings in North America
 - A worldwide reputation for education and research
 - Many collaborations and ties with industry



Introduction

- Dr. Dean Webster, Lead Researcher
 - Senior Scientist for Sherwin Williams
 - Research Associate and Eastman Chemical
 - Extensive Honors, Awards, Publications, and Patent Filings
- *“Revolutionary...”*
 - Platform Technologies
 - Significantly Improved Properties over Current Bio-Based Materials and Processes
 - Mechanical Properties Comparable to Non-Bio-Based Materials
 - Dramatically Increase Renewable Material Content

Technical Information

- Technologies Based on **Epoxidized Sucrose Ester Resins** (instead of Epoxidized Vegetable Oil)
- **2 to 4 Times** Number of **Functional Groups** per Molecule
- **Higher Crosslink Density** than Oil-Based Coatings
- Materials with **Excellent Tensile Properties, Hardness, Flexibility, Chemical Resistance, and Adhesion**
- **Faster UV Cure Rate** (~10 Times Faster) than Oil-Based
- **Variety of Cross-Linking (Curing) Mechanisms** Allow Technologies to be Tailored for Many Applications
 - For example, polyurethanes, amino resins

Key Features and Benefits

- **Green Technology**
- Platform Technologies Can Be “Tuned” to Perform in Many Applications and Markets
- Synthesis Uses Raw Materials, Reagents, and Processes Common to Industry
- Far Superior to Existing Bio-Based Materials
- Comparable to Petrochemical-Based Materials
- Elimination of Hazardous Components
 - Formaldehyde Free
 - Bisphenol-A Free



Potential Market

- **Bio-Renewable Chemicals Market**

- \$1.63 Billion in 2008, \$5 Billion by 2015

- (Source: “Strategic Analysis of the Worldwide Market for Biorenewable Chemicals”, Frost & Sullivan, December 2008)

- **4% is Coatings, Adhesives, and Enzymes**

- \$65 Million (2008), \$200 Million (2015)

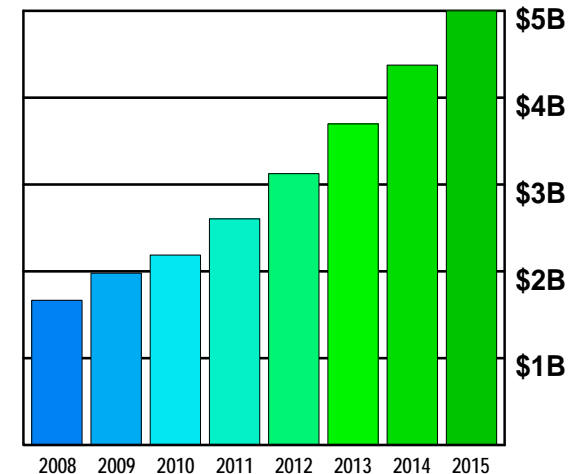
- Does Not Include Construction Materials, Other

- **Estimates are Conservative**

- Demand for Bio-Based Will Grow

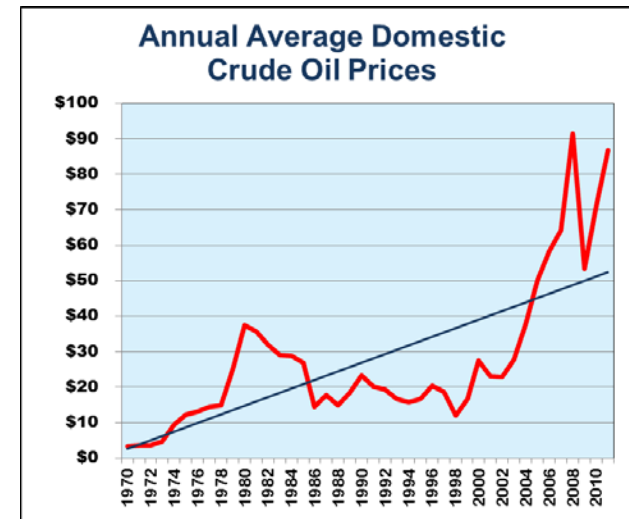
- Does Not Include Non-Bio-Based

Bio-Renewable Chemicals Market



Market Pulls

- Reduction of Dependence on Crude Oil
- Demand for Environmentally-Friendly Products
- Laws and Treaties
 - Executive Order 13514
 - Energy Policy Act of 2005
- Governmental Programs
 - USDA Bio-Preferred Program
 - Leadership in Energy and Environmental Design (LEED)
- UV-Curable Fastest Growing Segment of Coatings Industry



Key Application Areas

- Bio-Based Coatings
 - Laminate Flooring, Container Coatings, Baking Enamels, etc.
- Bio-Based Adhesives
 - Structural Adhesives, Heat-Laminated Materials, etc.
- Bio-Based Composite Materials
 - Building and Construction Materials, Rigid Foams, etc.
- Bio-Based Lubricants
- Bio-Based Inks

Market Impact

- These Technologies Achieve What No Bio-Based Materials Have Before
 - Vastly Improved Mechanical Properties
 - Reduced Hazardous Chemical Content
 - Readily Available Materials and Common Processes
- Have the Potential for a Significant Impact on the Bio-Based Materials Markets
- Positioned to Impact the Non-Bio-Based Market

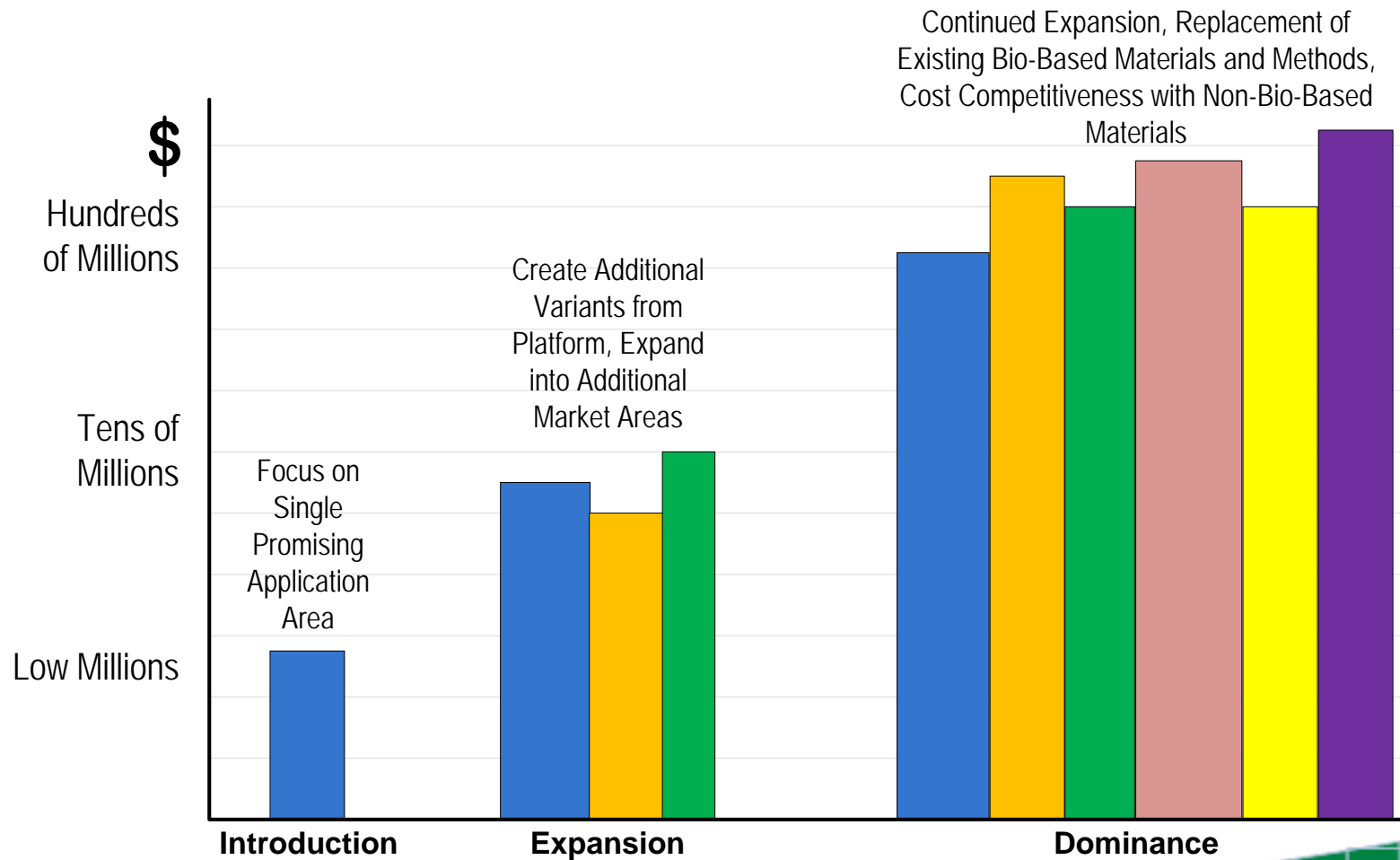
Intellectual Property

- Family of Four Related Technologies
 - RFT-314: Bio-Based, UV-Curable Coatings (Base Technology)
 - RFT-334: Bio-Based Thermoset Materials
 - RFT-337: Bio-Based Acrylate Functional Resins & Coatings
 - RFT-360: Bio-Based Polyols and Coatings
- Technologies are Patent Pending
- Immediately Available for License or Partnership.
- Owned by the NDSU Research Foundation

Value Proposition

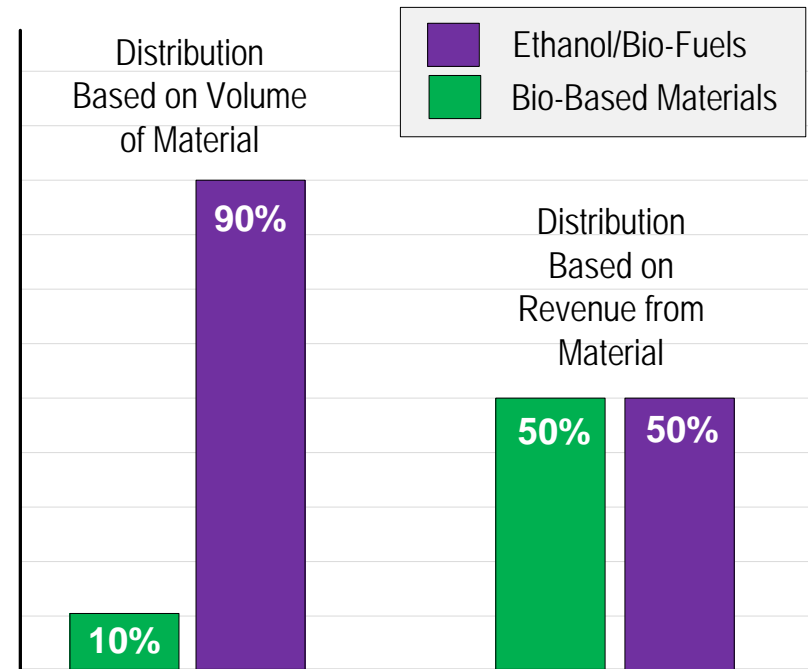
- Part 1: Can Easily Displace Bio-Based Materials Made from Epoxidized Oils
 - Significantly Better Properties
 - Cost Competitive
- Part 2: Properties Enable Advances on Petrochemical-Based Materials Market

Exponential Growth Scenario



Additional Value Proposition

- Products in These Markets are High-Margin
 - Ethanol/Fuels Market is High-Volume, Low-Margin
 - More Attractive from Investor's Point of View



Next steps

- Key Next Step is Optimizing the Commercial Process for One or More Application Areas
- Goals Include One or More of the Following:
 - A License with a Commercial Partner
 - Exclusive, Non-Exclusive, or Option
 - Funded Research at NDSU to Develop Applications
 - Investment in a ND-Based Start-Up
 - Lead Inventor as Chief Technology Officer

Contact Information

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- **Dr. Dean Webster, Lead Inventor**

- Professor, Department of Coatings and Polymeric Materials, NDSU
- Extensive Background in Industry
- Large number of publications and awards
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