Go Further

BioPolymers Development at Ford Motor Company

History of Biomaterials at Ford

- 1937 Ford was producing 300,000 gallons of soy oil a year for use in car enamels (*Soybean Digest* 1947).
- 1939 the Ford Motor Company was harvesting about 100,000 bushels of its own soybeans
- The "Soybean Car" was unveiled by Henry Ford on August 13, 1941
- 'Fordite' material used in steering wheels contained wheat straw

Robert Boyer and Henry Ford with the Soybean Car.

Soybean Car assembly image showing production of plastic panels.

"Someday you and I will see the day when auto bodies will be grown down on the farm."

– Henry Ford

Saturday Evening Post : Farm to Fender

1st

to "grow" automobile parts on the farm

It has always been a Ford conviction that agriculture and industry are natural partners. That is why Ford has pioneered the use of farm products as automobile materials.

Ford was the first car manufacturer to start growing its own timber. This was in 1919, when Ford purchased a large tract in Northern Michigan, to provide a dependable source of both hard and soft woods.

Ford was the first car manufacturer to acquire its own rubber plantations.

Ford was the first car manufacturer to provide its own tung oil for paints and enamels, by planting tung tree groves.

And perhaps the most striking example of this partnership of farm and factory is the Ford development of the soya bean. Ford was first to sow, harvest and use the "miracle bean" as a basic industrial material. The soya bean has long been an ingredient of synthetic resin enamels and plastic parts for Ford-built cars. This Ford "first" brought impetus to the plastics industry. It gave farmers a new "money crop".

Today many products go from farm to Ford, to contribute to the beauty, performance and economy of Ford-built cars and trucks. And these products benefit owners and farmers alike, because they bring new values on the one hand . . . new income on the other. Here is another of the Ford advances that mean so much to America.

Tune in . . . THE FORD SHOW . . . CBS, Tuesdays, 10-10:30 P. M., E.S.T. THE FORD SUNDAY EVENING HOUR . . . ABC, Sundays, 8-9 P.M., E.S.T.

Ford

EXPECT THE "FIRSTS" FROM FORD!

Ford's Commitment

"Ford is committed to offering customers affordable, ***environmentally friendly technologies*** *in vehicles they really want. We are focused on providing solutions that can be used not for hundreds or thousands of cars, but for millions of cars because that is how Ford can truly make a difference."*

-Alan Mulally
President & CEO
Ford Motor Company

Ford's Sustainable Materials Strategy

- **Vision**
  - **Ford Motor Company will ensure that our products are engineered to enable sustainable materials leadership without compromise to Product Quality, Durability, Performance or Economics.**

- **Key Positions**
  - **Recycled** and **renewable** materials must be selected whenever technically and economically feasible. We will encourage the best green technologies to meet the increasing demand for these materials.
  - When we use **recycled** and **renewable** materials, there will be no compromise to Product Quality, Durability & Performance or Economics.
  - We will enhance technologies, tools and enablers to help validate, select and track the use of these materials in our products.
  - The use of **recycled** and **renewable** content is increased year by year, model by model where possible.

Ford's Plastics Development Process

Research

- New material identification
- External collaborations
- Understanding of material property performance
- Identify competing incumbent materials
- Overcome technical challenges
- Business case development
- Supplier engagement

Materials Engineering

- Test materials according to Ford material specifications
- New specification development for new classes of materials
- New material qualification and approvals
- Application development

Product Development

- Application development
- Identify potential programs and Tier 1 suppliers
- Schedule production level molding trials
- Perform component level testing
- Engage purchasing
- "Go – no go" decision makers

Corporate Sustainability Team: LCA, corporate strategy, public affairs

Driving Green Solutions For **All** FMC Vehicles

Use of Plastics in Vehicles Today

- Over 300lbs of plastic in cars
  - Exterior, interior, underhood and electronic applications
- 100 different grades of plastic used
  - Need to meet requirements for appearance, rigidity, resistance, weight, durability and cost
- Challenges for Plastics
  - Competition from steel
  - Many processing technologies (IM, BM, thermoform, etc)
  - Price volatility since plastics are petroleum derived
  - Recyclability at the end of life
    - difficult due to number of plastics.
- Many opportunities to make current plastics more sustainable!!!!!

Unique Technical Challenges

- **Automotive Interior** – challenging environment
  - high heat: 85° C (top center of IP)
  - humidity: 90-95% RH in southern FL
  - sun load
  - performance maintained over lifetime of vehicle – 10 years/ 100,000 miles

- Some bio-polymers will degrade with exposure to heat & moisture
  - balance between durability & compost-ability
- Cycle time issues with material processing
- Hard for new materials to compete with commodity plastics
- Extensive supply chain

Success of Soy-based Foam

Applications: Use of functionalized soy oil in urethane foam for automotive seating and headliner applications

Status: Ford is leader in technology and first OEM to launch in production; migration to other non-automotive applications

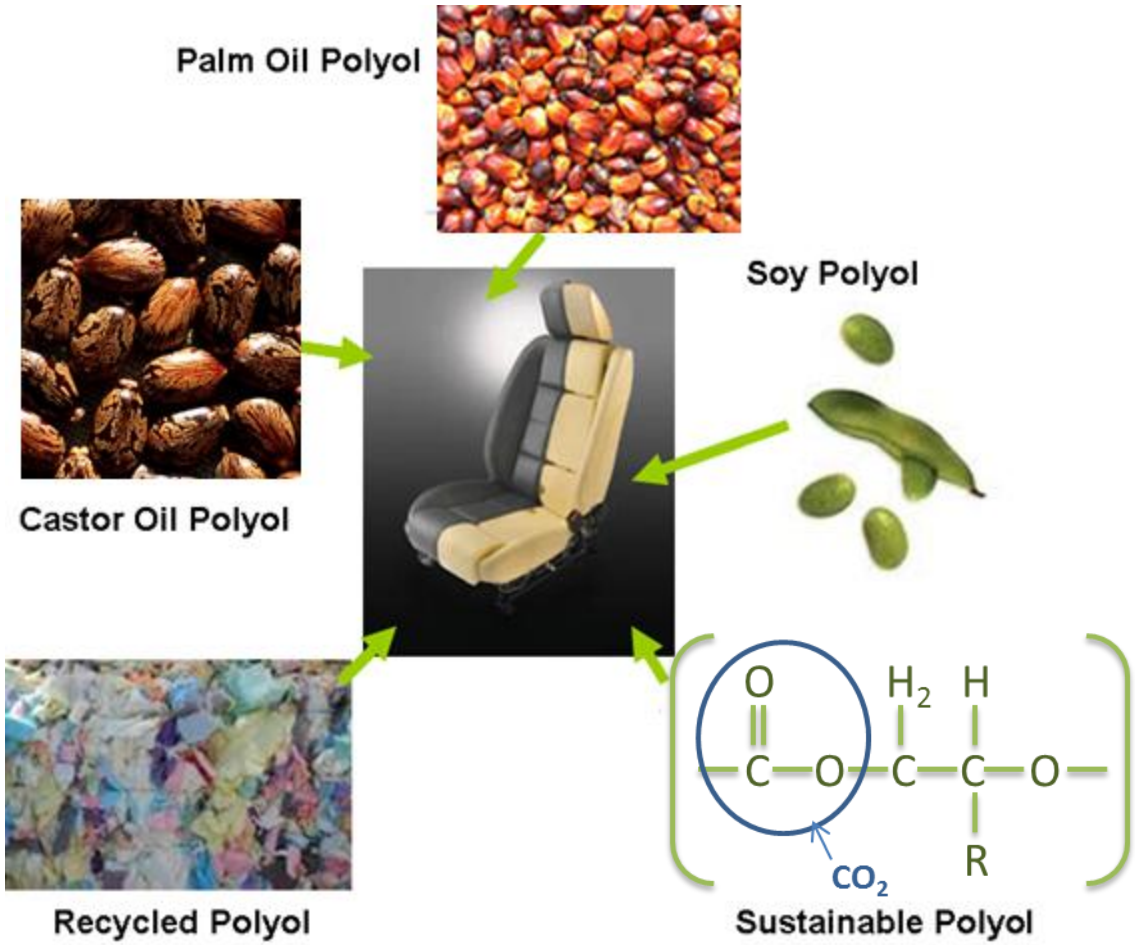
Soy foam headliner

Soy foam seats

- Soy foam seats on all vehicle platforms in North America!!
- Over 5 million Ford vehicles on the road today have soy foam seats
- Escape has soy foam headliner
- 75% headrests contain soy foam
- Reduces petroleum usage by 5 million lbs annually & CO2 by 20 million lbs

Future Green Ideas for Foam

- Sustainable sources other than soy must be considered for regions where soy is not as plentiful
- Moving forward to combine "green ideas" to improve sustainability



Bio-based Thermoplastic Resin Research

- Goal: Overcome performance and durability issues of neat PLA:
  - Performance additives for PLA (nucleating agents, impact modifiers, moisture inhibitors)
  - PLA blends with other thermoplastic resins (PC, ABS)
- Goal: Evaluate processability and performance of renewably sourced polyamides
  - Identify the right applications
- Goal: Enter into emerging bio-materials space of developing traditional polymers from renewable monomers and chemical feedstocks

PLA Automotive Applications

Opportunities:

- Textiles
  - Carpet
  - Floor mats
  - Upholstery
- Manufacturing
  - Packaging
  - Protective wrap
- Interior – Injection molded applications

Challenges to Overcome :

- Durability
- Impact requirements
- HDT
- Processing

Injection Molded PLA Durability

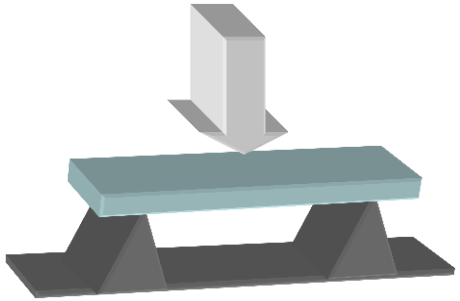
Durability:

- Must meet automotive requirements for long term heat and humidity
- Accelerated conditioning:
  - 50 C/ 90RH or 70 C/ 90RH
  - want samples to retain properties

Injection mold materials

Condition samples in environmental chamber

Characterize samples after various times



GPC: Molecular Weight
IR: Chemical Composition
DSC: Crystallization Behavior
Flexural Testing: Strength

Sustainable Polymer Modification

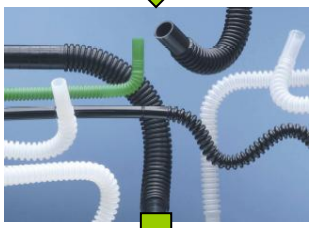
1. **Blends of resins with PLA**
2. **Bio-based rubber** (for either PLA or PP)
   - Russian dandelion and guayule (GY)can produce high-quality domestically sourced natural rubber
   - Partnering with OSU –OARDC to develop
   - Potential use as a rubber modifier in TPO or bio-based plastic materials for interior trim applications

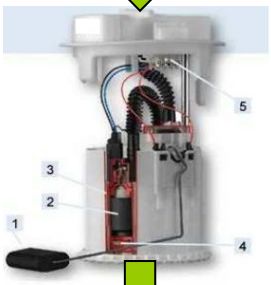
Bio-based Polyamides (castor derived)

- Obtain monomers from castor bean oil
  - PA10,10
  - PA 6,10
  - PA 4,10
  - PA11
- Benefits
  - Castor beans are not food source
  - High mechanical strength
  - Excellent chemical and stress cracking resistance
  - High HDT
  - Low moisture absorbance
  - Can be cost effective replacement of metal or rubber in highly technical applications

Bio-based Nylon 11 Usage

- Nylon 11 – 100% derived from castor bean oil
- Used in fuel tubes (in-tank)
- 95% of Ford vehicles use this product
- Reduce petroleum usage by close to 1 million lbs/yr
- Reduce CO_2 emissions by 1.1million lbs/yr (compared to PA12)
- Potential to migrate to other high performance under the hood applications





ARKEMA

FRÄNKISCHE
INDUSTRIAL PIPES

Ford

Bio-based Monomer Technology

- Producing traditional plastics (PP, PE, PA, PET, PBT) from bio-based feedstocks rather petroleum
  - Utilize bio-chemical reactions
  - Good long term durability
    - (Can be used in existing processes)
  - Known performance and attributes
  - Reduce dependence on foreign petroleum
    - Local supply
    - Multiple material sourcing possible
  - Improved carbon footprint

Collaboration:100% Plant-PET

COCA-COLA, FORD, HEINZ, NIKE, AND PROCTER & GAMBLE FORM COLLABORATIVE TO ACCELERATE DEVELOPMENT OF PRODUCTS MADE ENTIRELY FROM PLANTS

Five Global Companies Demonstrate Their Strong Commitment to Sustainable Innovation

Atlanta, GA – June 5, 2012 – The Coca-Cola Company, Ford Motor Company, H.J. Heinz Company, NIKE, Inc. and Procter & Gamble today announced the formation of the Plant PET Technology Collaborative (PTC), a strategic working group focused on accelerating the development and use of 100% plant-based PET materials and fiber in their products. PET, also known as polyethylene terephthalate, is a durable, lightweight plastic that is used by all member companies in a variety of products and materials including plastic bottles, apparel, footwear and automotive fabric and carpet.

Thank you for your attention