



**ACRES Group**



# **New Soy-based Materials for Automotive Applications**

**Dr. Richard B. Chapas,  
Cara Plastics Inc.**

**Dr. Richard P. Wool,  
ACRES Group Director, University of Delaware.**

## Presentation Outline

- CARA Plastics and ACRES
  - **Goals and Activities**
- New Soy-based Resins
- Adhesives
- Foams
- All-natural Composite Materials
- Potential Automotive Applications



**ACRES Group**



## **CARA Plastics Inc.**

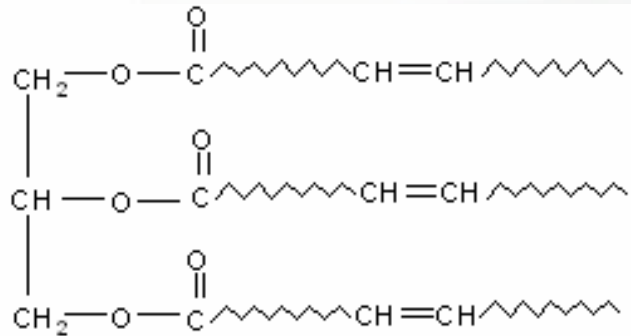
- **Cara Plastics, Inc. ("Cara") has exclusive worldwide rights to the technology for converting natural oils to high value resins for a variety of commercial applications.**
- **One patent has been issued, and two others filed.**
- **Cara has an exclusive license from the University of Delaware to commercialize this technology and utilize the resources of the Composite Center.**

## ACRES Group Activities

**ACRES group was awarded DoE funding for the following applications:**

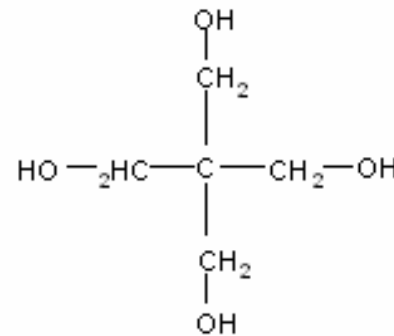
- Automotive and Trucking
  - **SMC, Natural Fibers, Foam, Resins**
- Adhesives and Resins
  - **PSA, Coatings,**
- Structures
  - **Hurricane Resistant Housing**

## Synthesis and Polymerization of Soybean Oil Pentaerythritol Glyceride Maleates (SO/PER/MA)

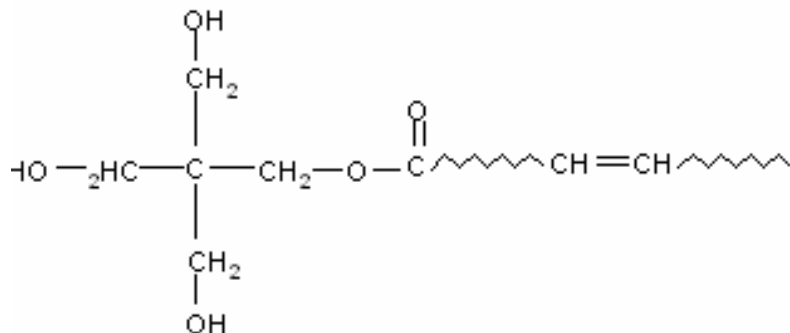
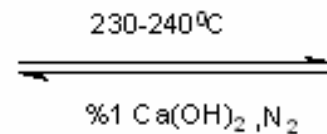


**Soybeanoil triglyceride**

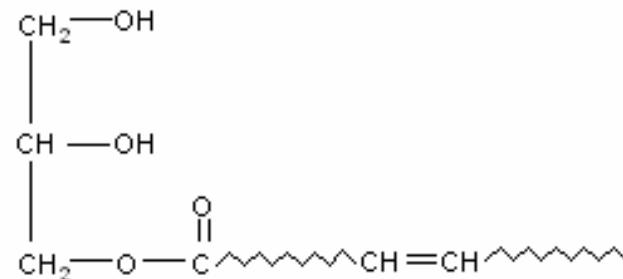
+



**Pentaerythritol**

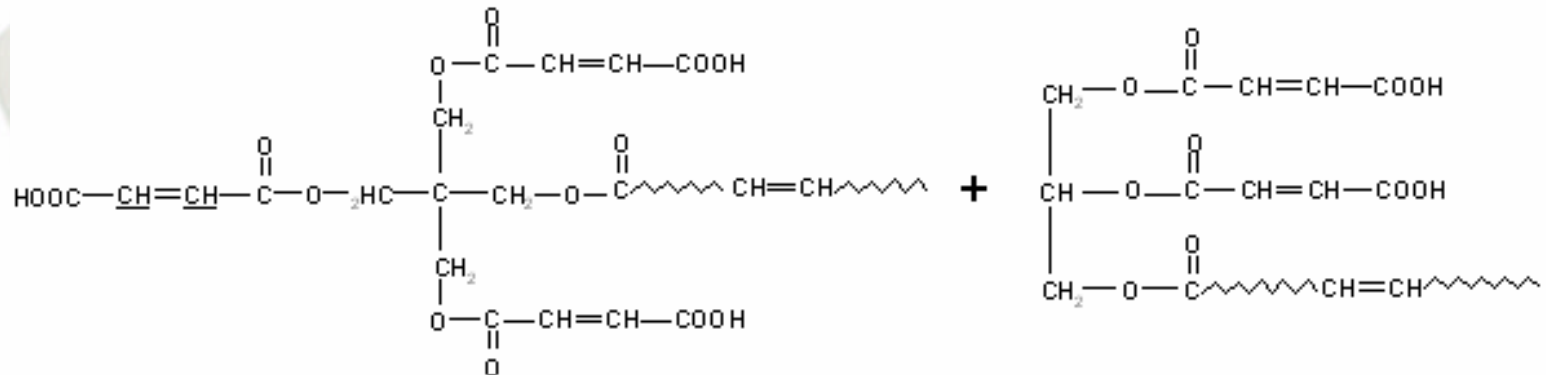


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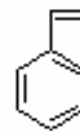
1% Triphenyl antimony  
0.1% Hydroquinone

T=100°C



**Pentaerythritol glyceride tris-maleate half ester**

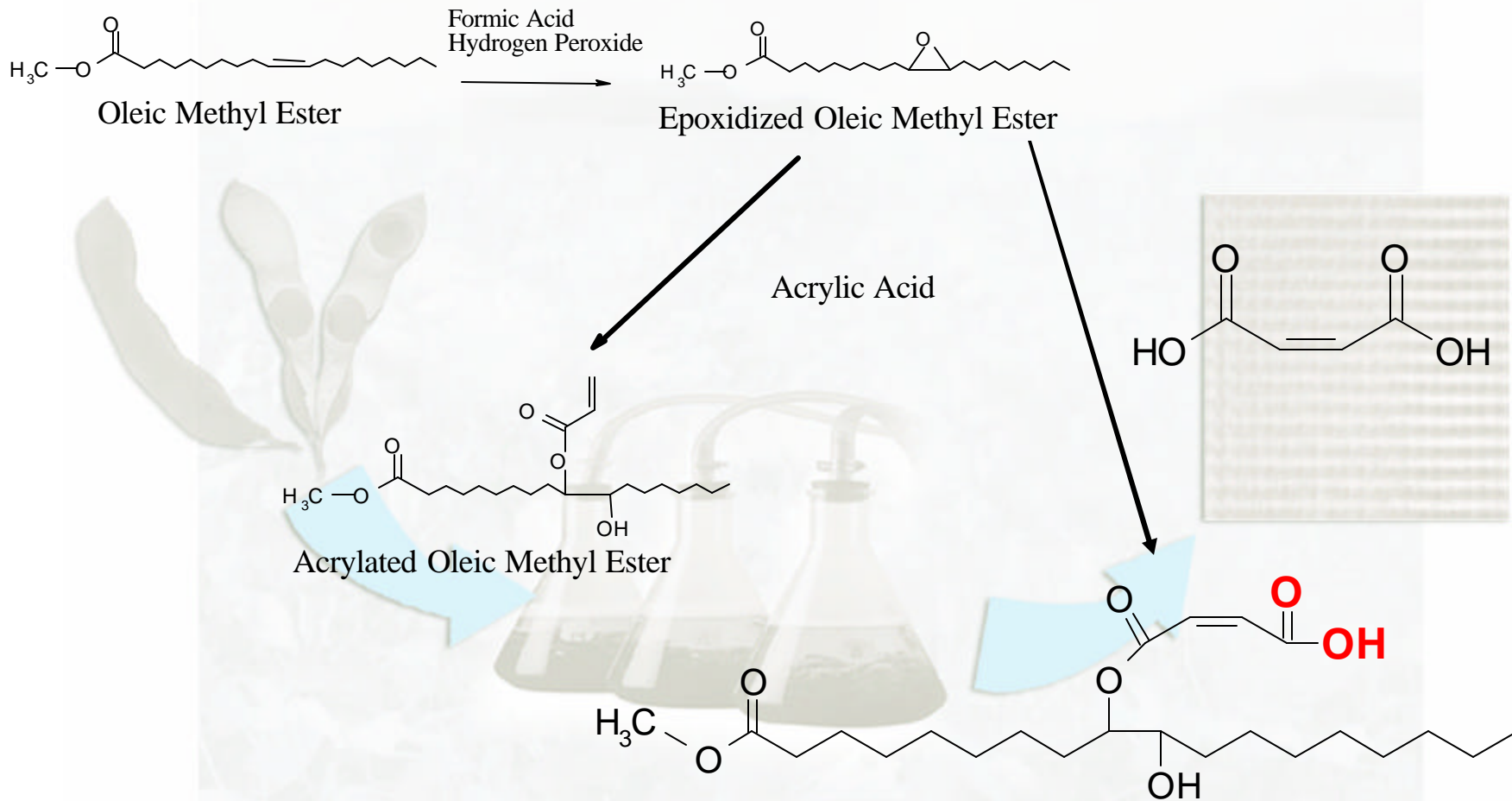
**Monoglyceride bis-maleate half ester**



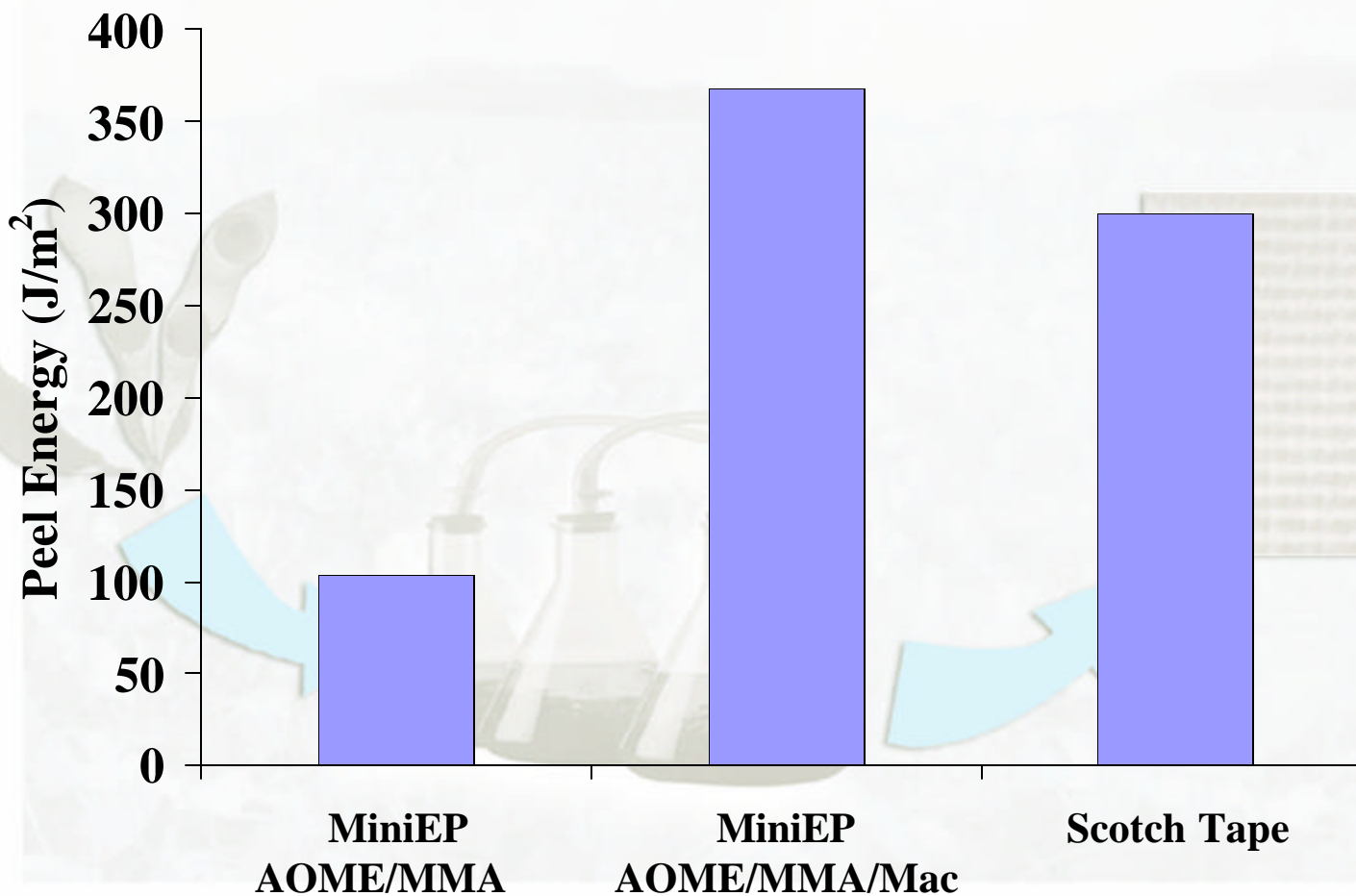
Free radical copolymerization

**Rigid Thermosetting Polymer**

## Adhesives



## Modified Adhesive Properties



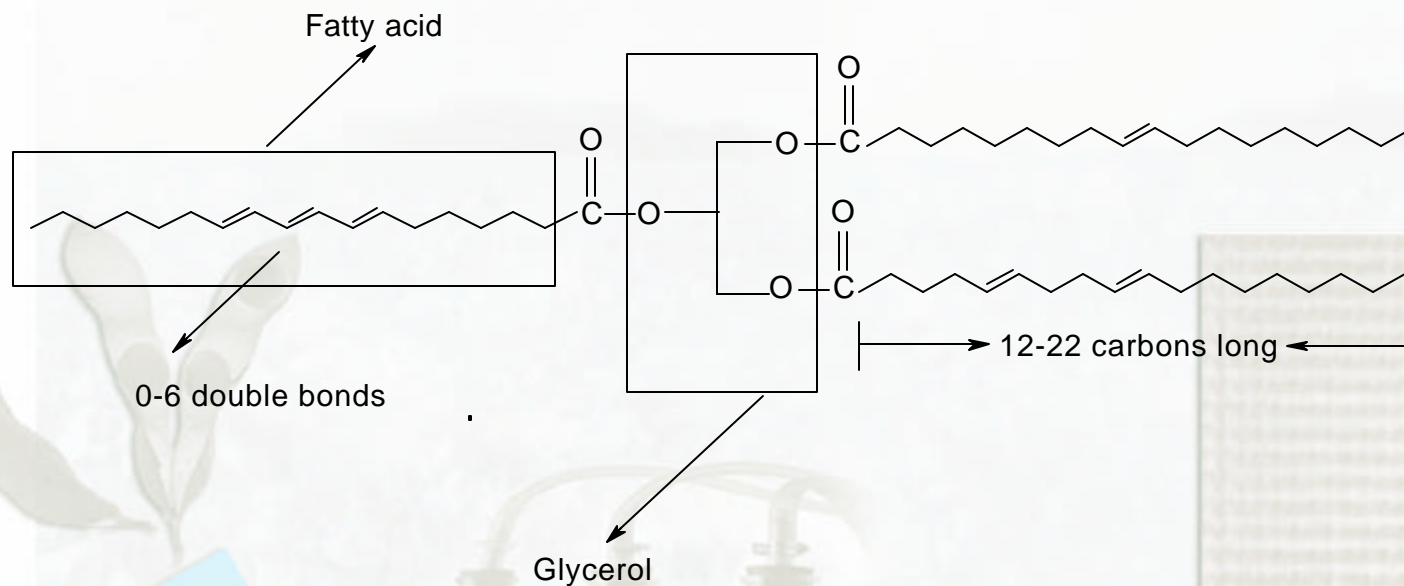


## All-Natural Composite Materials

- Resins
- Fibers
- Processing
- Current Applications
  - Housing
  - Furniture
  - Infrastructure



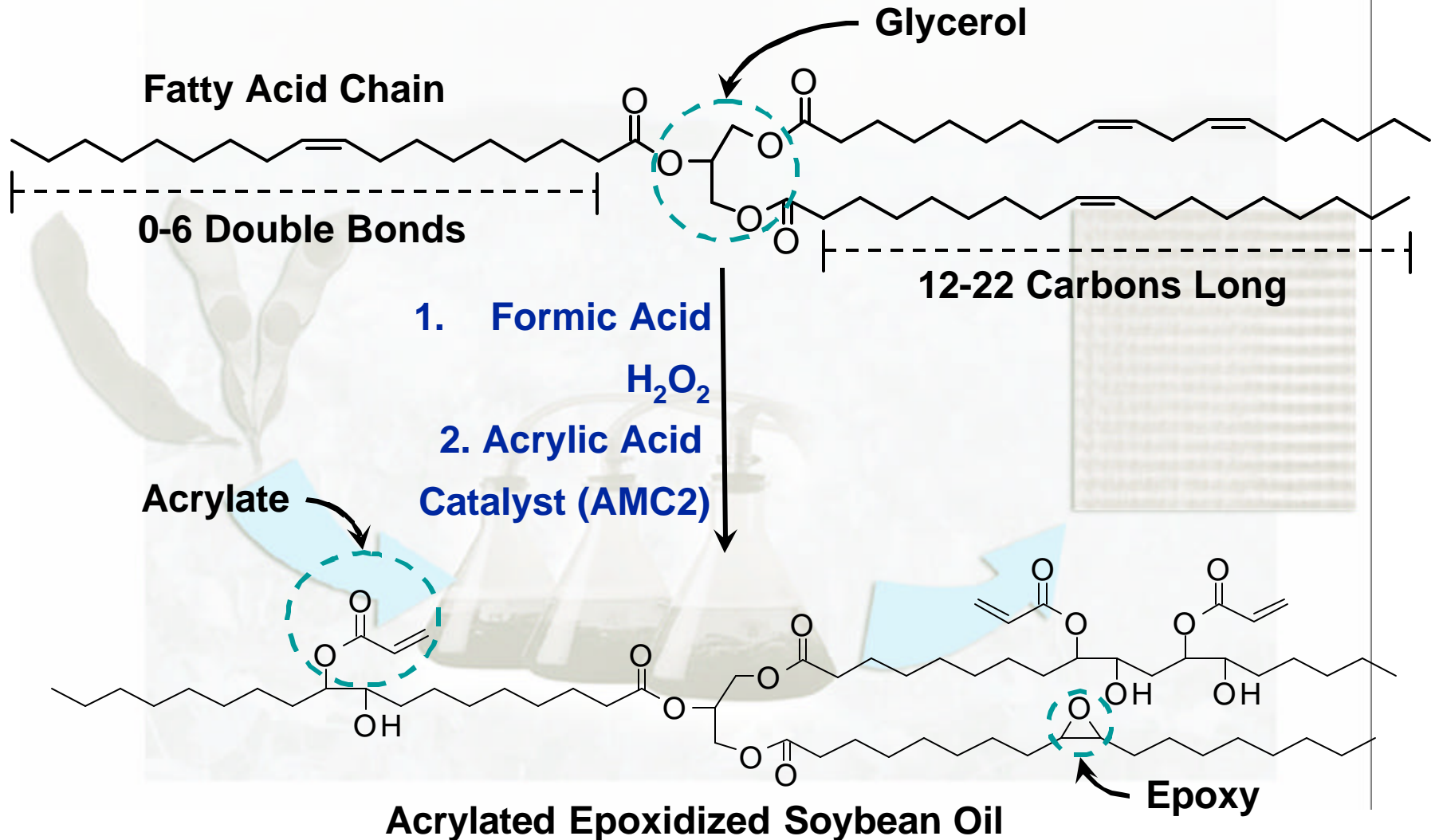
## Chemistry of Soybean Oil: Triglyceride



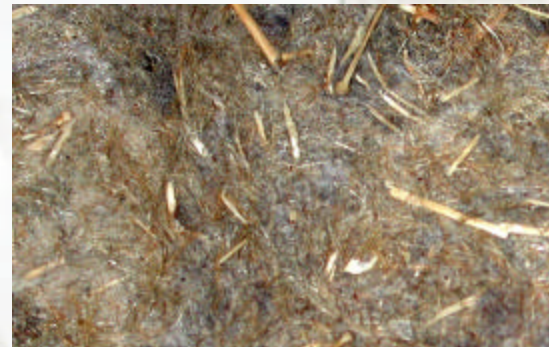
**Fatty acid weight composition of soybean oil.**

Fatty Acid	Formula	Weight %
16:0	C <sub>16</sub> H <sub>32</sub> O <sub>2</sub>	11
18:0	C <sub>18</sub> H <sub>36</sub> O <sub>2</sub>	4
18:1	C <sub>18</sub> H <sub>34</sub> O <sub>2</sub>	25
18:2	C <sub>18</sub> H <sub>32</sub> O <sub>2</sub>	51
18:3	C <sub>20</sub> H <sub>40</sub> O <sub>2</sub>	9

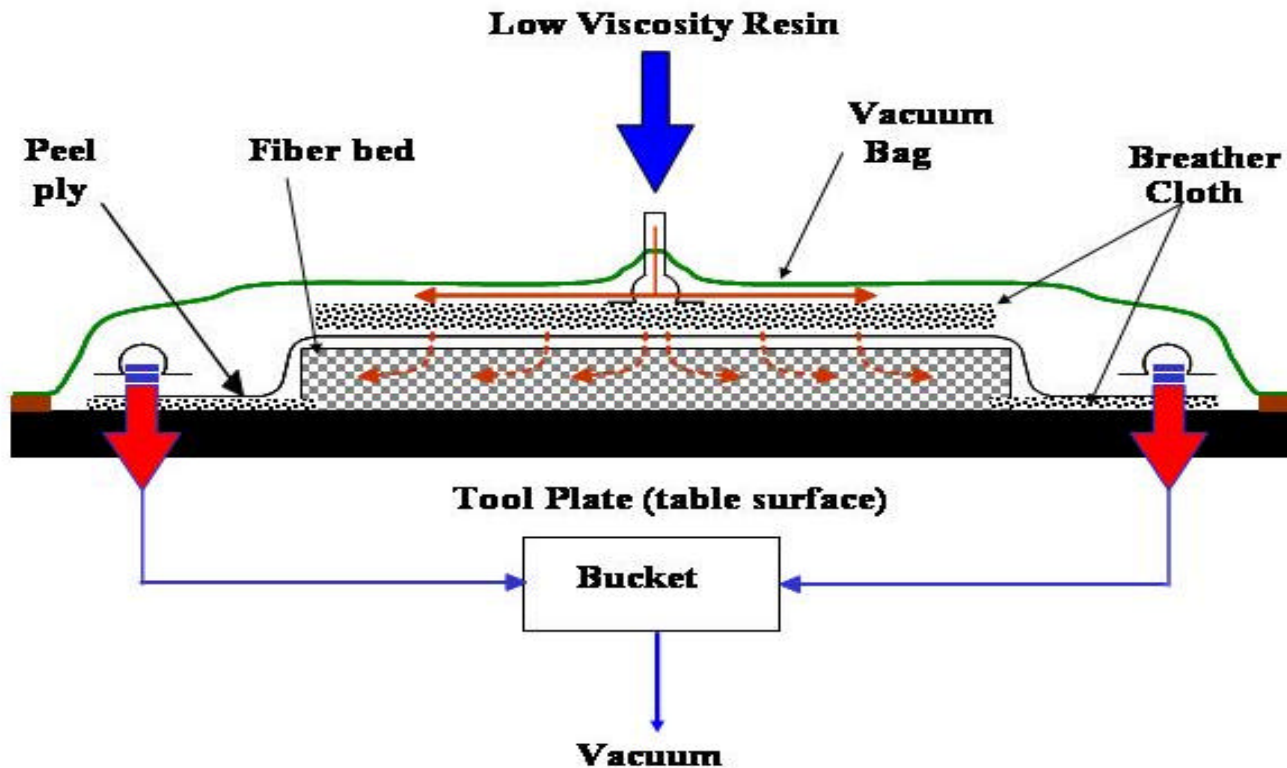
## AESO Resin Chemistry



## Natural Fibers –Flax and Cellulose



# Processing: Vacuum Assisted Resin Transfer Molding (VARTM)

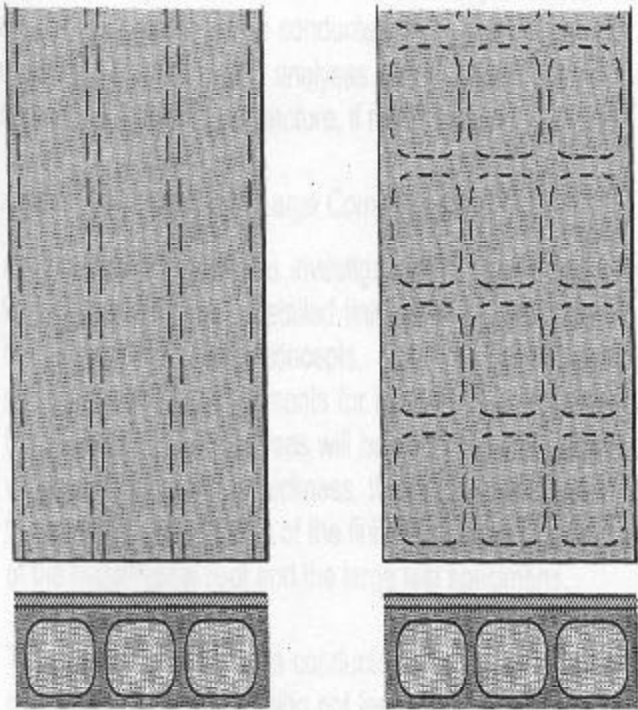


## Current Applications

- **Housing**
  - Hurricane Resistant Structures
- **Furniture**
  - All-natural Composite Chair
- **Transportation Infrastructure**
  - Stay-in-place Form for Bridge Decking

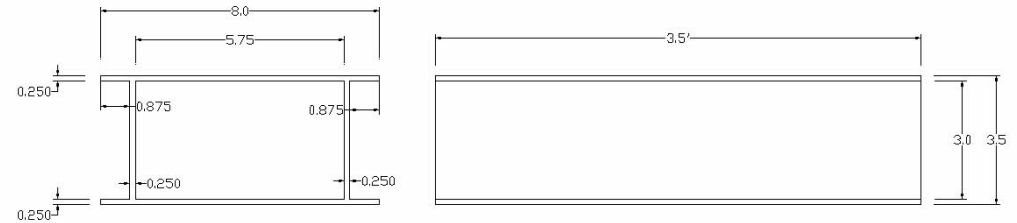


## Roof: Design and a Unit Beam Schematic



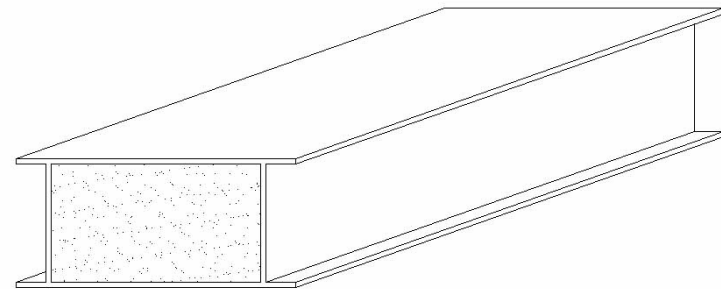
rafter foam core

waffle foam core



SECTION

SIDE VIEW



## HRS Unit Beam: Manufacturing

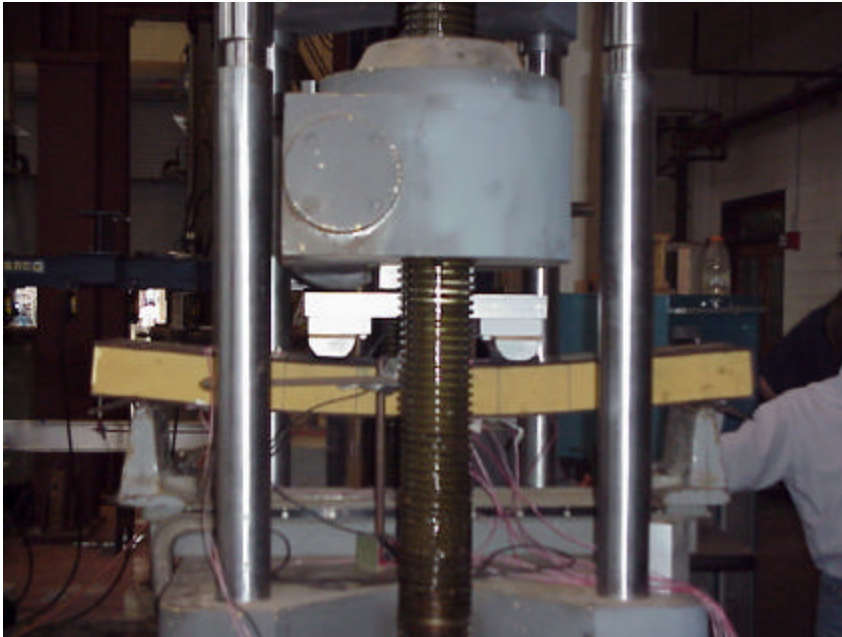




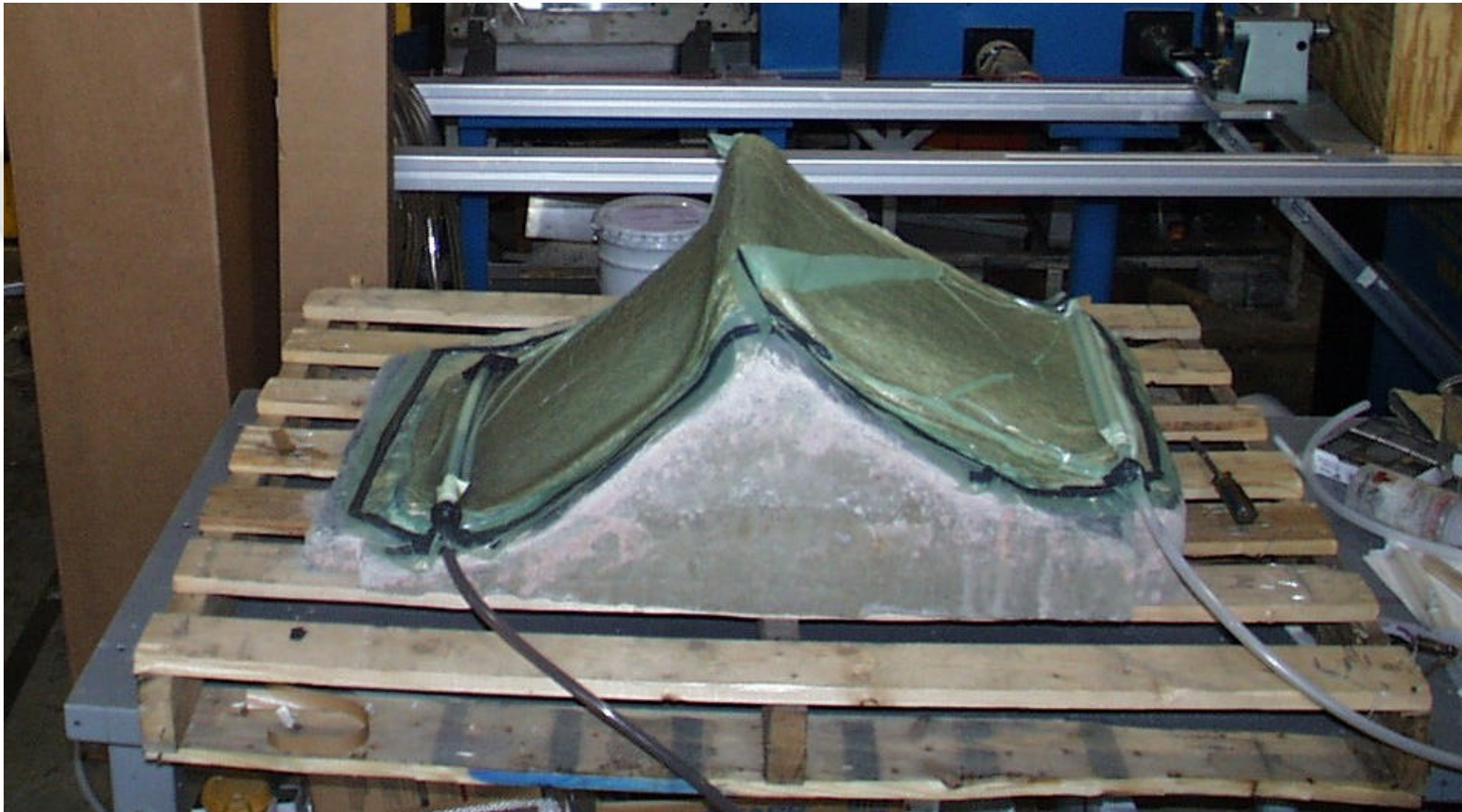
## Structural Unit Beam



## HRS Unit Beam: Testing



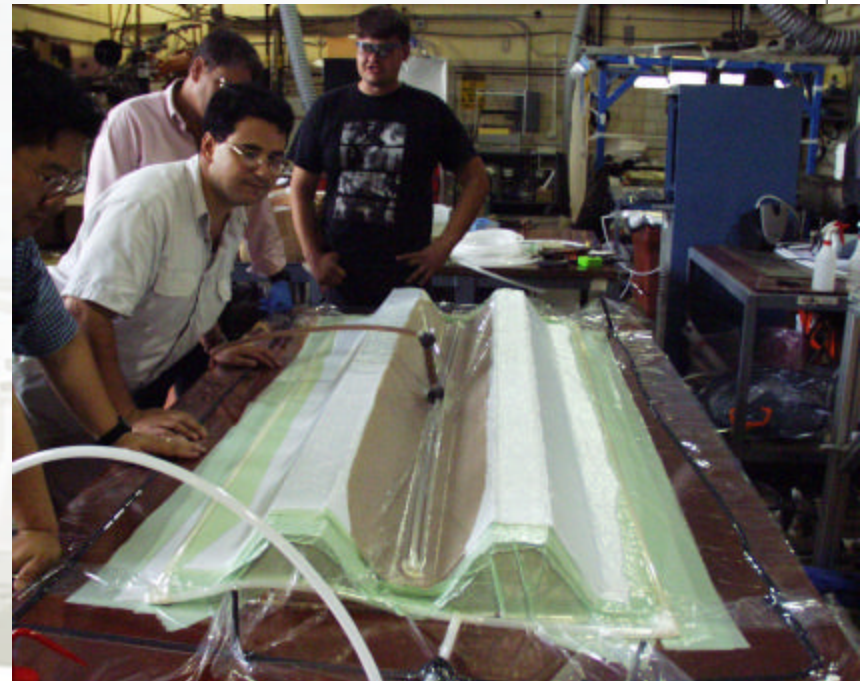
## All-Natural Composite Chair: Manufacturing



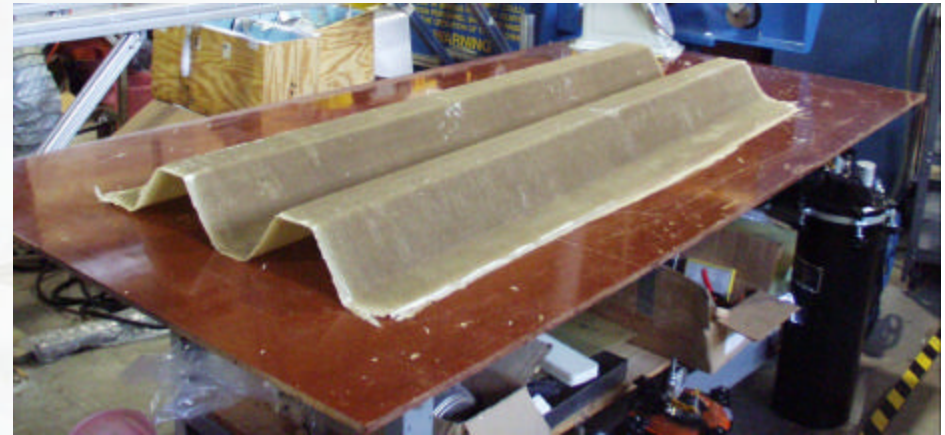
## All-Natural Composites Chair



## Stay-in Place Form for Bridge Decking: Manufacturing



## Highway Bridge: Stay-in-Place Form for Bridge Decking



## Stay-in-Place Form for Bridge Decking: Testing



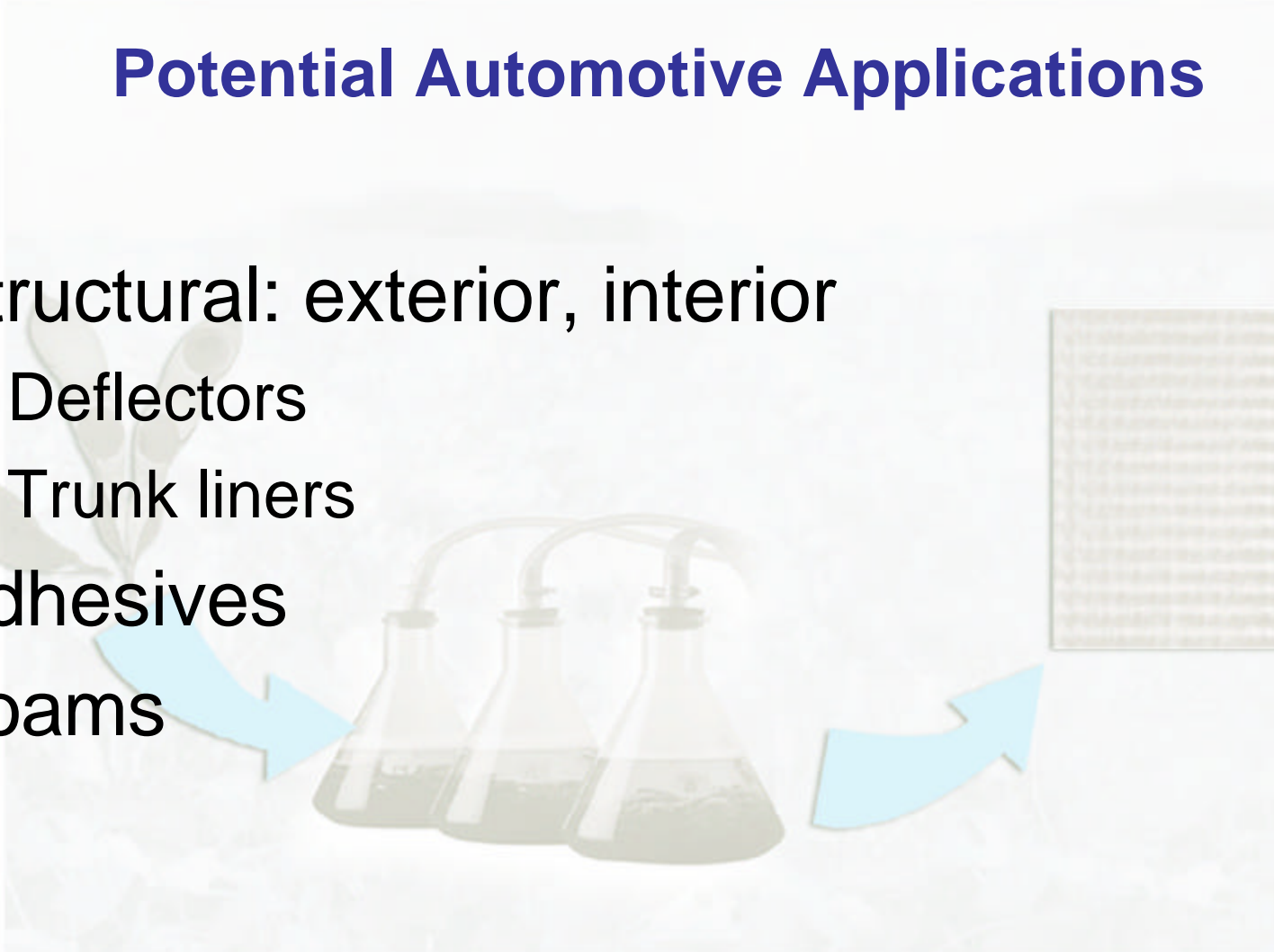
## Stay-in-Place (Bridge Deck) Form: Testing with Concrete





## Potential Automotive Applications

- Structural: exterior, interior
  - Deflectors
  - Trunk liners
- Adhesives
- Foams



## Summary and Next Steps

- Resins and composites are available for testing and tailoring for specific end-uses.
- Adhesives are available for testing and formulation.
- Foams are in early stage development for work with partners.
- Contact Cara for licensing and joint development opportunities.

## Acknowledgement

- ACRES Group
  - Dr. Mahmoud Dweib
  - Ann O'Donnell
  - Erde Can
  - Shana Bunker
- Center for Composite Materials