Lightweight Bio-Composites with Acrodur® Resin Technology

Henning Karbstein
Jeremy Funk, John Norton & Dr. Gero Nordmann
BASF Corporation
Presentation Overview

Key Market Trends / Technology Drivers

Resin Chemistry & Material Advantage
Hansa Mixer FOAMLINER / RF Systems Dryer
Target Composite Applications
Summary
CAFE Standards requiring improved fuel efficiency

- 35.5 mpg by end of 2016
- Increase to 54.5 mpg by 2025

Strategies to meet rising standards

- Vehicle energy efficiency
- Power train / propulsion
- Weight reduction

Interconnected

Reducing vehicle weight allows for extended driving distances for alternative engines (electric or hybrid)
Auto Lightweighting Market Drivers

- Auto lightweighting goals are driven by:
  - Changes in fuel economy/emissions government regulations
  - Rising/fluctuating fuel prices
  - Ever growing global warming concerns
  - Electric, other fuel systems development
  - Spiraling car weight increases caused by continual addition of car features

- Transportation OEMs and suppliers, want to achieve vehicle lightweighting goals without loss of performance or aesthetics

- Material selection is impacted by assembly methods, formability, paint technologies, and corrosion protection requirements

- Weight reducing material selection is also impacted by:
  - Material availability in quantities required for series volume production
  - Cost per unit of weight saved
  - Material weight saving potential per vehicle produced

- The drive for lightweighting results in materials technology increasingly being considered as part of the initial design
Automotive Weight Saving Solutions

Materials Poised for Growth

- Advanced Composites
- Aluminum
- Fibers
- Ceramics
- Steel
- Plastics
- Bio-Based Materials
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Summary
Acrodur® thermoset binders provide opportunity to
- Produce very-durable composites & nonwovens
  - Lower weight at comparable performance or
  - Increase performance at same wall thickness
- Reduce or eliminate VOCs, Odor & Fogging
- Address rising demand for “green” materials
Acrodur® solutions consist of two components, dissolved in water

...a polycarboxylic acid:

Both components react at temperatures above > 130°C

...and a polyalcohol:

...to form a polyester
Acrodur® dispersions consist of two components, dissolved in water...a polycarboxylic acid, modified with a latex component:...

...and a polyalcohol:

Both components react at temperatures above > 130°C to form a latex-modified polyester.
Combines properties of thermoplastics & thermosets

Before cure: thermoplastic behavior
- Provides low-viscosity & excellent wetout of a wide variety of particles & fibers
- Allows production of prepregs / semi-finished goods

After drying & curing (at elevated temperatures): thermoset behavior
- Forms lightweight, durable thermoset
- Possesses excellent thermal, mechanical, & chemical stability
- Reduces VOCs, shelf-life storage issues
Crosslinking Behavior of Acrodur® Resins

Thermal crosslinking

Modulus

Thermoplastic

Thermoset

Temperature [°C]
Wide Range of Properties Available

E-Modulus

Before curing
After curing

hard

„stiff-duroplastic“
„tough-duroplastic“

Acrodur® 950 L
Acrodur® DS 3515
Acrodur® DS 3558
Competitive Mechanical Performance

Density vs. Mass / Unit Area

All Materials Natural Fiber (NF) Reinforced or Wood Fiber

- Acrodur-NF
- NF-Polyurethane
- NF-PP
- NF-Epoxy
- Wood Fibre
Competitive Mechanical Performance

Spec. Flexural Modulus vs. Spec. Impact Strength

- NF-Epoxy
- NF-Polyurethane
- Acrodur-NF
- Wood Fibre
- NF-PP
Resin to Matrix Prepreg Methods

Production Flexibility

- Can be applied to reinforcement / substrate via
  - Dipping (Bath)
  - Spraying
  - Foaming
  - Blow-Line
Material Advantage

Acrodur® and Natural Fibers

- pH compatible with natural fibers
- High molecular bond between resin and fiber
- Fiber surface fully covered and internally infused in resin
- Resin impregnates completely within the cellulose structure significantly reducing H₂O absorption and increasing overall composite mechanical properties
- Full color pigment capable to custom design finish appearance
- No harmful VOC during production (off gases H₂O only)
- No VOC off gassing over life of product
Technology Benefits

• Eliminates harmful off gassing resulting in a healthier work environment

• Reduced tool maintenance costs

• High strength to weight (weight down) compared to other thermal set and thermal melt resonated non woven matrix’s containing natural fiber.

• Reduced matrix water absorption (natural fiber) post mold

• End of life recycling through capturing energy value—no harmful emission result

• Easily pigmented which transfers fibers to color of choice
Processes for Applying Acrodur® Resin

- Dipping and Squeeze fiber mat into resin bath and squeeze out surplus
- Direct foam injection in mat—precise application, best direct application cost
- All application systems can be sized for bulk application or sized to stand alongside (inline to) molding lines
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The Hansa Mixer FOAMLINER opens new dimensions in the penetration of substrates like natural fiber mats by foamed reactive BASF Acrodur® resin or binding agents.

Foam impregnation with the FOAMLINER provides constant surface weights at all line speeds to nonwoven material manufacturers.

The newly developed design of the foam application beam guarantees an equal foam distribution across the entire application width.
Hansa Mixer FOAMLINER Basics
Hansa Mixer FOAMLINER Features
Radio Frequency (RF) Prepreg Drying

FoamDryer
Radio frequency dryer for foamed reactive resins

Being able to dry quickly, evenly and with a very low energy consumption is a requirement every day more important in the automotive industry. Our radio frequency technology, based on the evenly excitation of the water molecules inside the product, ensures the best results for the drying of foamed reactive resins or binding agents applied to Non Wovens and fiber mats. The final outcome are panels lightest and strongest for the next generation of automotive products.

- Developed with industry experts
- Even and uniform drying
- Reduced energy consumption
- Low maintenance
- Small and compact size
RF Systems Dryer Line
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Characteristics of natural fiber composites

**Substrates**
- Wood fibers
- Seed fibers: Cotton
- Bast fibers: Kenaf, Jute, Hemp, Flax...
- Non-Woven fibers: Glass, Polyester...

**Main application areas**
- Automotive (ca 5 – 10 kg natural fibers are used in each car)
- Recreational and Truck Vehicle Panels and Components
- Furniture Chairs and Tables

**Main automotive products**
- Door trims
- Rear window shelves
- Sound isolation parts
- Seat shells...
Automotive Interior Composite Applications
RV & Truck Interior Applications

- Recreational Vehicle (RV)
  - Cabinet
  - Tables
  - Structural Floor
  - Interior Wall Panels
  - Door Systems
  - Overhead Liner
  - Exterior Wall panels

- Truck Interior Trim
  - Headliner
  - Door Panels
  - Center Console
  - Bunk Panels
Natural Fiber Composite Chair

- An Acrodur® biocomposite fabricated chair was presented at the Chicago NeoCon.
- The chair’s seat and back are made from compression molded panels of Acrodur® binder and renewable raw materials.
- Natural fiber load in the composite part can be up to 75-80% of the finished article.
- The chair shows that using this technology, cost-efficient, 3D objects which are both extremely stiff and lightweight can be produced.
Broad Based Application Development
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- Composite usage in automotive is growing – addressing need for light weighting
- Interest in renewable materials is growing – addressing need for “green”
- New materials need to meet or exceed cost/performance requirements
Acrodur® thermoset resins help satisfy all trends

- Can meet automotive interior specifications
- Enable lighter, thinner parts
- Allow high fiber content composites (reduce use of non-renewable materials)
- Eliminate VOCs
The End

Thank You for Your Attention

Questions?