



ACC115 High Volume Processing of Composites

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This presentation does not contain any proprietary or confidential information



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ACC115 High Volume Processing Purpose

- **Investigation of new/advanced composite processing technologies**
- **Direct support of the Materials, Joining, and Carbon Fiber SMC Working Groups**
- **Direct collaboration Focal Project 4 via Material and Process Evaluations**
- **Facilitate next steps for projects**



ACC115 High Volume Processing Approach

- **Identify & contact major supplier's on willingness to work on ACC projects**
- **Show suppliers long term strategy**
- **Find commercial equipment to resolve scale-up issues**
- **Work with suppliers and ORNL on development of lower cost carbon fiber**



ACC115 High Volume Processing Barriers

- **Major supplier's:**
 - Do not have equipment
 - Unwillingness to work with ACC
 - Focused on short term profits
- **Carbon fiber shortage**
- **Scale up issues from research to commercial size**



ACC115 High Volume Processing Materials Working Group – Purpose

Develop materials in a format that can be molded & tested for the materials database which will enable the development of thermoset and thermoplastics for structural & semi-structural applications.



ACC115 High Volume Processing Materials Working Group – Approach - Barriers

Materials - Thermoplastic- Approach

Polypropylene-based

- Used by all OEM's
- Relatively inexpensive
- Easily recyclable
- Multiple processing techniques
- Comes in multiple formats

Polyamide-based

- Used by all OEM's
- Multiple processing techniques
- Comes in multiple formats
- High service temperature
- High strength, impact & toughness
- Easily bonded

Polyester-based

- Used by all OEM's
- Multiple processing techniques
- Comes in multiple formats
- High service temperature
- High strength, impact & toughness
- Recyclable
- Easily bonded

Materials – Thermoplastic - Barriers

- Limited service temperature
- Hard to bond to

- Recyclable but no code
- Higher cost
- Must design for WAM & DAM
- Must be dried before molding
- High processing temperatures

- Higher cost
- Limited chemical resistance
- Generally must be dried before processing
- High processing temperatures

ACC115 High Volume Processing Materials Working Group – Approach

Material Format

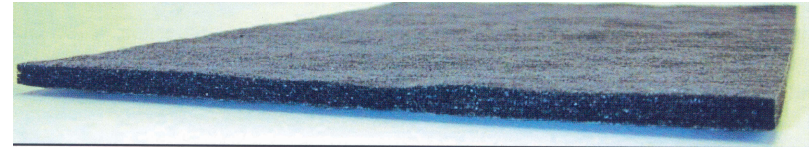
- **Pellets**

- Come in common lengths of 11 mm, 25 mm and 50 mm



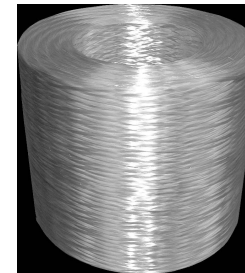
- **Mats**

- Come in chopped, woven & unidirectional



- **Raw material – ILC/D-LFT**

- Glass
- Masterbatch
- Resin





ACC115 High Volume Processing Materials Working Group – Approach

Processing & Tooling

- **Injection molding or injection/compression molding**

- Standard pellet
- ILC/D-LFT

- **Compression molding**

- Standard pellet
- ILC/D-LFT
- GMT

- **Other**

- P4
- Tape laying
- Vacuum forming

- **Combinations of above processes for use as inserts or local reinforcements**

- **Tooling guidelines:**

- P-20 steel
- Full round runners with no sharp corners
- Keep sprues as short as possible
- Use vacuum when necessary
- Charge placement can be critical

- **Processing guidelines:**

- Low L/D ratio
- Low compression ratio
- Minimum backpressure
- Fast acting presses
- Large nozzle openings



ACC115 High Volume Processing Materials Working Group – Approach

Reinforcements

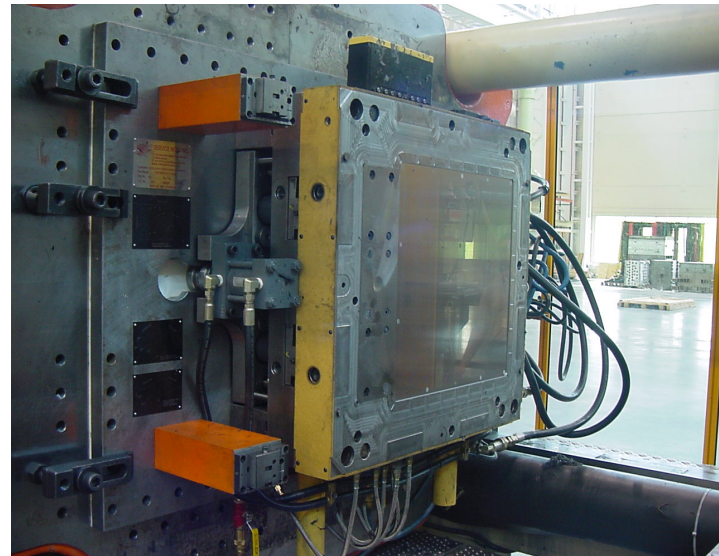
- **Fibers**
 - Carbon
 - HMPP (high modulus polypropylene)
 - Kevlar
 - Sorona
 - Basalt
- **Nano composites**
 - Clay
 - NanoTalc
 - NanoCalc
- **Cores**
 - Thermoplastic
 - Cardboard
 - Foam
 - Balsa
- **Combinations of above materials**

ACC115 High Volume Processing Accomplishments

Compression Tool



Injection Tool





ACC115 High Volume Processing Accomplishments

Compression Tool

- 609.6 mm x 609.6 mm
- P-20 tool steel
- Variable part thickness
- 5 pressure sensors
- 5 temperature sensors
- Vacuum
- Chromed surface

Injection Tool

- 609.6 mm x 609.6 mm
- P-20 tool steel
- Variable part thickness
- 5 pressure sensors
- 5 temperature sensors
- Husky long fiber hot runner system
- Two potential injection locations
- Configurable end gate



ACC115 High Volume Processing Joining Working Group - Purpose

- **Investigate new and advanced joining techniques for composite to composite and composite to metal joints.**
- **Develop a method to optically detect, quantify, and predict Bond-Line Read-Through to enable use of minimum thickness panels.**



ACC115 High Volume Processing Joining Working Group – Approach

- **Joining Methods in Sandwich Composites**
 - Investigate adhesion of PP/carbon & Nylon/carbon composites with combinations of surface treatments & adhesives
 - Demonstrate improved face sheet/core adhesion
- **Bond-Line Read-Through (BLRT)**
 - Develop a tool that provides an objective way of quantifying the severity of BLRT
 - Complete a series of DOE's to determine root cause of this appearance defect
 - Use root cause data to develop a CAE tool that can predict occurrence of the defect in the design phase



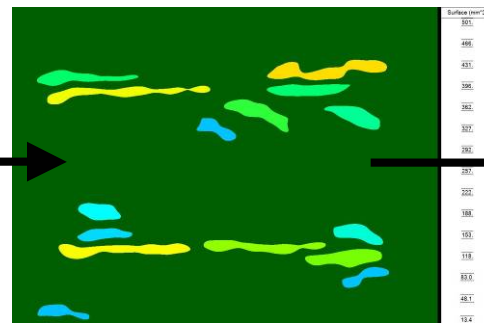
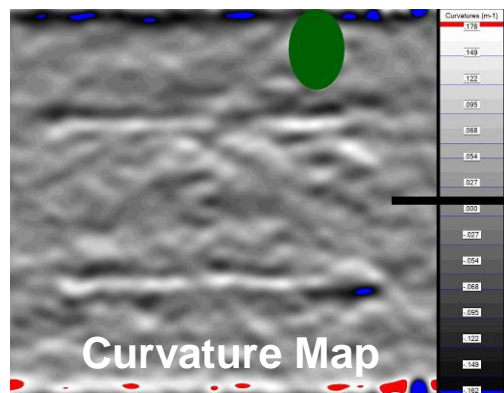
ACC115 High Volume Processing Joining Working Group – Barriers

- **Bond-Line Read-Through**
 - **Extracting numerical data that correlates with visual assessments for all types of defect “signatures”**
 - **Controlling manufacturing variation sufficiently so control factor effects are clear in experiments**
 - **Evaluating the large number of possible control factors and interactions**

ACC115 High Volume Processing Joining Working Group - Accomplishments

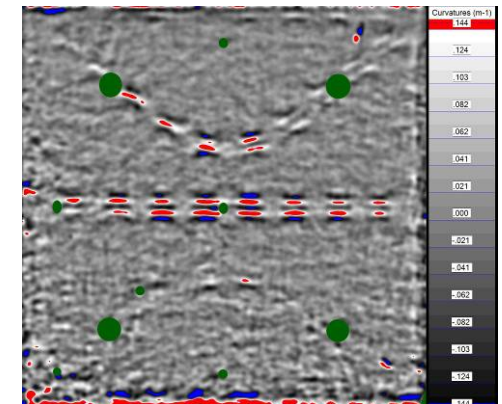
▪ Bond-Line Read-Through

- Developed a measurement based on curvature amplitude and area that converts a defect's physical characteristics to a numerical assessment of its visibility



BLRT
Score = 28.5

- Completed first designed experiment to begin investigation of defect root cause





ACC115 High Volume Processing Carbon Fiber SMC – Purpose - Approach

- **Purpose –**
 - **To develop a carbon fiber reinforced SMC with physical properties and processing significantly superior to current carbon fiber SMC materials.**
- **Approach –**
 - **Work with a Tier One automotive SMC supplier to investigate and develop an improved material. Development to be focused on low cost carbon fibers.**



ACC115 High Volume Processing Carbon Fiber SMC – Accomplishments

▪ Accomplishments –

- Agreement with Tier One Supplier to modify their SMC compounder adding carbon fiber capability. In-kind compounding / molding to be provided. Supplier is partnering with Tier Two carbon fiber supplier for material and coupling agent development.**
- Compounder upgrade started in January, 2008. Currently developing plan for resin selection, fiber tow size adjustment, and fiber/resin interface optimization.**