Film Processing Module for Automated Fiber Placement

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Introduction and Background

- Composite Processes and Fabrication Team, MPM Dept.
- Recent work focused on 2nd Gen RLV & NGLT Technology
- Micro-cracking/Permeability Issues for Liquid Cryogen Tanks
- Fabrication Trade Studies for Very Large Composite Tanks
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*Introduction and Background: Genesis of Concept*

**Team Focus: Reusability of Propellant Tanks**
- Micro-Cracking of Polymer Matrix Due to Thermal Cycling
- Manufacturability Issues: Out-of-Autoclave, Tooling Concepts, etc.
- Studies: Permeability of Various Polymers/Films to LOX, LH

**Not Captured:**
Fabrication of Structures Having Barrier Films/Foils and/or Core Adhesives ⇒ Scale: Technology for Manufacturing of Large (30 ft. x 90 ft.) Propellant Tanks
Fiber Placement Process Description

[Diagram showing components of fiber placement process]

- Individual tow payout with controlled tension
- Band collimator
- Tow cutters and clamp mechanism
- Compaction roller
- Part surface
- Direction of head travel

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Technology Benefits

- Enhancement of the Fiber Placement Process
- Simultaneous Placement of Films/Foils into Laminate During Ply Lay-up Cycle or as Separate Step
- Device May Be Designed as Add-On or Integrated into New Fiber Placement Machinery
- Ease of Attachment and Removal of Module to Host Machine
- Slave-Control Operation for Ease of Integration
- Reduction in Part Costs due to Reductions in Cycle Time
- Capability Extends to Automated Deposition of Core Adhesives

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Technology Definition: Module Specifications

Dimensions: 17in. x 8.5 in. x 10 in.
Weight: 12.5 lbs.

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Technical Details: Applications

- Titanium/Graphite Laminates (TiGr)
- Glass/Epoxy/Aluminum Laminates (GLARE)
- Embedded Lightning Strike Protection
- Liners/Permeation Barriers
- Embedded Sensor Arrays
- Adhesives
- Processing
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Technical Details: Applications

Barrier Layers

Core Adhesives

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Technical Details: Attachment to FP Head

Film Module On Viper Placement Machine

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Technical Details: Attach Points
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Technical Details: Controls

Electrical Controls Enclosure

Hand Pendant Control

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Technical Details: Prototype Specifics

- PLC-Based Controls (ladder logic)
- Fully-Adjustable Device Sequencing and Timing via Speed/Motion Sensor
- Pneumatic Material Feed and Cut System uses Shop Air
- Electrical Power: 120 VAC
- Variable Power IR Radiant Heat Source for Substrate/Film Heating
- Simple Guillotine-Style Material Cutting System with Vacuum Hold
- Uses Host Machine Compaction Roller: May be Designed with Independent Heated Roller and/or Heated Trailing Shoe
Simultaneous Placement

Shared Compaction Roller

Independent Compaction Rollers

Separate Placement

Independent Compaction Rollers

Composite

Film/Foil/Adhesive

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Technical Advantages
- Reduction or Elimination in Hand Lay-up
- Improvement in Quality
- Reduced Fabrication Costs
- Can Be Added to Existing FP Machines or Designed as Integral (fixed or detachable) for New Machines
- As an Add-On: Slave-Control for use of Existing Placement Files, Minimizing Integration Work
- Quick Attach and Removal from Host Machine
- May Process T/S or T/P Films & Metallic Foils
- Capable of Processing Variable Material Thicknesses and Widths (1in., 3 in., etc.)
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R&D Status
Engineering Prototype Designed for Demonstrations
And Testing at MSFC

Prototype has been Bench-Tested and Fit-Checked to Viper Placement Machine

Remaining Work:
Full-Scale Processing Demonstrations
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Remaining Work: Initiate Processing Trials

• Simultaneous and Separate Placement of Films and Composites
• Trials Using Materials of Different Thicknesses
• Trials with Metallic, Aluminized and Polymeric Films
• Overlap/Gap Studies
• Analysis and Mechanical Property Evaluations
• Publication of NASA Technical Memorandum
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*NASA Plans/Options*

- Provisional Patent filed May ’04
- Non-provisional Patent to be filed June ‘04
- NASA Seeks Partners to License this Technology
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NASA’s Technology Transfer Program

• Program seeks to stimulate commercial use of NASA-developed technology and infuse commercial technology into NASA missions.

• NASA is flexible in its agreements for licensing or partnerships for co-development. Opportunities in patent licensing include exclusive, non-exclusive, or exclusive field-of-use agreements.

• For more information, visit the NASA exhibit or contact Sammy Nabors: NASA/MSFC Technology Transfer, 256-544-5226, sammy.nabors@nasa.gov
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