

STRENGTH IMPROVEMENT OF LAMINATE OBJECT MANUFACTURING (LOM) MOLDS



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ABSTRACT

The fabrication of composite parts with Vacuum Assisted Resin Transfer Molding (VARTM) require complex shaped molds.

This research develops a rapid prototyping station based on Laminated Object Manufacturing (LOM).

The system will have several features such as

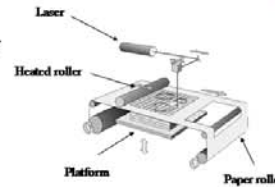
- ✓ Low cost,
- ✓ Flexible,
- ✓ Rapid, and
- ✓ Repeatable.

GOAL

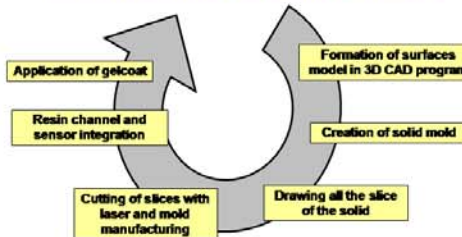
- ✓ Evaluation and improvement of mechanical properties
- ✓ Improvement of durability
- ✓ Validation by manufacturing of small scale LOM molds

LAMINATE OBJECT MANUFACTURING

1. Placing of adhesive coated paper layer on platform
2. Bonding of layer by heated and pressed roller
3. Cutting of paper layer and stack cutting



LOM MOLD MANUFACTURING PROCESS



TEST OF ADHESIVES

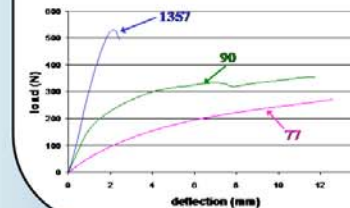
Goal : Choose the adhesive that have the best ratio between the quality and the price for room temperature applications.

3 adhesives has been chosen :

I	3M Multipurpose 77	~ 0.45 \$/m ²
II	3M Hi-Strength 90	~ 1.02 \$/m ²
III	3M Scotch grip 1357	~ 3.7 \$/m ²

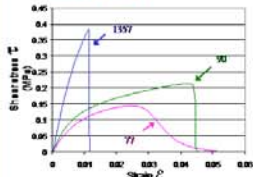
3-Point Bend

Goal : Compare the stiffness of 3 paper samples made with different adhesives



TEST OF ADHESIVES

Shear Test



Compression Test



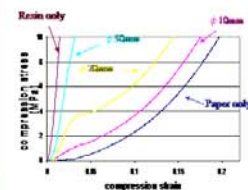
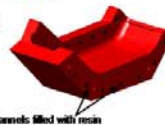
Adhesives 77, 90 and 1357 have the same behavior
 The stiffness of the adhesive does not influence the stiffness of the laminate

Conclusion : Adhesive 90 has been chosen because it has the best ratio between the price and the mechanicals properties

IMPROVEMENT OF THE STABILITY OF THE PAPER

Goal: Create stiffeners inside the mold

- Build a composite mold made with paper and resin
- Vinyl ester resin has been chosen



Channels filled with resin
 Compression test to choose the optimum channel diameter : 20 mm is enough

Conclusion : Resin stiffeners can be used inside a mold to increase its mechanicals properties

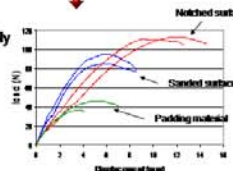
TEST OF GELCOAT

Goal: Characterization of the bonding of the gelcoat to the paper



Three different way to apply the gelcoat have been compared :

- Sanded surface
- Notched surface
- Padding material



Conclusion : Sanding the surface of the mold is not necessary

CONCLUSIONS

- The LOM process can be used as a low-cost rapid prototyping method to manufacture molds/master molds for composite parts.
- With the described process, it's possible to manufacture mid-size, thin, complex-shaped composites that don't require post-curing.
- Paper based LOM mold can be used from room temperature to 70°C (158°F) because of the adhesive used.
- In order to increase the temperature range (250°F), applications of different materials are possible (polyester sheets and high temperature adhesives).

FURTHER WORK

- Manufacturing of LOM molds to validate durability.
- Application of different material to replace the paper in order to improve the durability and the temperature resistance.

ACKNOWLEDGEMENTS

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