New Bagging Concepts For Vacuum Consolidated Cure

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Scaling of bagging and new bagging concepts

Conventional and current available reusable bags

- Reusable bags can be used for around 10's of parts
- Currently made by hand / no automation
- Seamless

Research Needs

- Evaluate automation concepts for spray-on bag
  - Robotic Spray-On applicator
- Developed spray-on bag (thin) and/or improved reusable bagging materials
- Investigate simple and low-cost barrier layer
  - Needed for Spray-On Vacuum Bag
  - Allows integrated breathing
  - Improves life cycle for reusable bag

➔Provide recommendations for an optimum configurations of a bagging structure (materials, geometry)

Commercially available spray-on bag systems

- SR Composites Sprayomer
- Distributed by Ashland
- Smooth-on.com EZ-Spray® Silicone
- SWORL* vacuum bagging systems

- Typically applied for multiple uses(10's of parts)
  - Requires support structure
  - Storage (size) is often a problem
  - Repair is often needed
  - Required thickness drives material usage and cost
  - Not compatible with many resin
- Opportunity of single-use spray-on bag
  - Application can be completely automated
  - Thickness and thus cost can be significant reduced
  - No storage required

New Bagging Concept

Sealing to mold required
No contact to resin, so can be thin
Spray-On application

- One layer
- No sealing required
- Same placement head as prepreg layup

Challenges:

- Permeability of bag has to be low but can be finite to maintain good vacuum level in breather
  - Evaluate spray-on bagging air permeability as a function of thickness and temperature
  - Evaluate cost benefit of a spray-on bagging for low production cycle numbers
- Membrane has to be compatible with resin
  - Effect of stretching and temperature on resin and air permeability has to be evaluated

System needed to evaluate both membrane and bagging permeability under various process conditions (temperature, stretching)

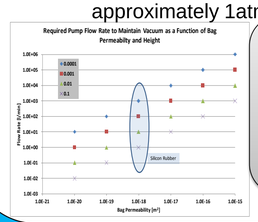
Importance of Permeability of Bagging Material

- Permeable Bagging Material

Total bag air bleeding is a function of pressure difference, geometry and permeability

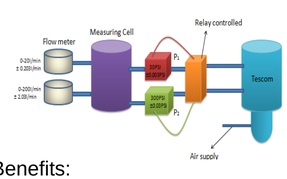
- Larger parts leak significantly more
- Almost perfect vacuum is desired at any location under the bag

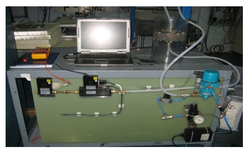
➔ pressure difference across bagging material is approximately 1atm



For such a large structure bagging surface will leak. Proposed bagging structure with membrane allows continuous vacuum degassing. Future work will investigate real pressure loss under bag surface and evaluate various spray bags permeability as a function of temperature.

Porometer Development for Permeability Measurements

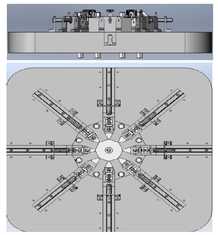


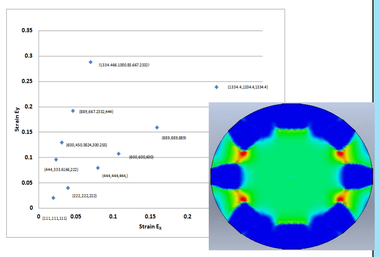


Benefits:

- Allows evaluation of out-of-plane air permeability of bagging (low) and membrane material (high)
  - Small sample size
  - Can be used to evaluate effect of *temperature*
  - Can evaluate effect of *stretching* with new stretching adaptor
- Membrane resin compatibility can be measured
  - Fluids can be "infused" through-the-thickness as a function of pressure
- Additional potential application
  - In- and Out-of-Plane air permeability of new prepreg systems

Controlled Stretching Machine





- Machine is currently being built
  - Can be attached to porometer
- Uniform strain in center (active area of porometer)
- Built to allow more than 50% strain on a typical membrane material

ACKNOWLEDGEMENTS

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