BIO-BASED COMPOSITE MATERIALS

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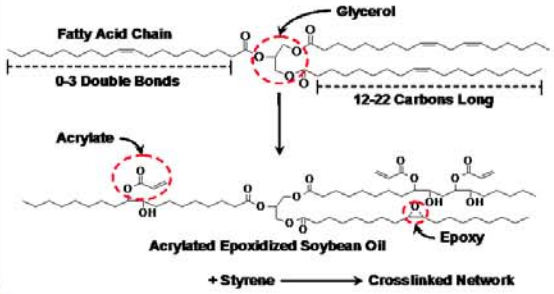
Introduction

The objective of this study is to develop all-natural composite materials out of soy oil based resin and natural fibers such as flax, cellulose, hemp, recycled cardboard boxes, paper, and newspaper, and chicken feathers.

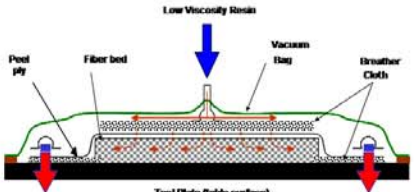


Fiber Mats

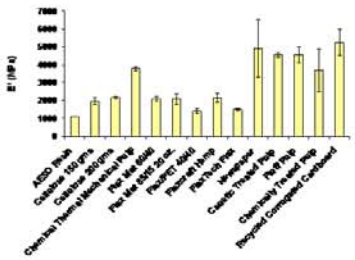
Chart Reference	Description
Flax/PET 40/40	40% Flax 40% PET 20% Starch Binder, supplied by Cargill Ltd.
Flax Mat 60/40	60% Flax 40% Binder, supplied by Cargill Ltd.
Flax Mat 85/15 20 oz.	85% Flax 15% Binder 20 oz., supplied by Cargill Ltd.
Cellulose 200 g/m²	Air Laid 200 g/m² 84% cellulose 16% binder, supplied by Concept Fabrication, Canada
CTMP Pulp	Chemical Thermal Mechanical Pulp, supplied by M&J Fibretech a/s, Denmark
Fluff Pulp	Wet Laid Fluff Pulp Low Density Mat 100% Cellulose 640 g/m², supplied by Rayonier
Chemically Treated Pulp	Chemically Treated Pulp Contains a Hydrophobic Debonder, supplied by Rayonier
Caustic Treated Pulp	Caustic Treated Pulp 100 % Cellulose High Porosity Mat used for Filtration Products, supplied by Rayonier
Cellulose 150 g/m²	Air Laid 150 g/m² 82% cellulose 18% binder, supplied by Concept Fabrication, Canada
Flaxcraft Hemp	550 g/m² non-woven Hemp, supplied by Flaxcraft
Flaxtech Flax	Flax Distribution of flax fibers with varying lengths and low binder content, supplied by Flaxtech
Newspaper	Newspaper
Recycled Paper	110 g/m² Recycled Paper from Cardboard Boxes, supplied by Interstate Resources, PA, USA
E-Glass Fiber	Woven E-Glass

Two pictures showing a flax mat and a chicken feathers mat

Composite Processing using VARTM



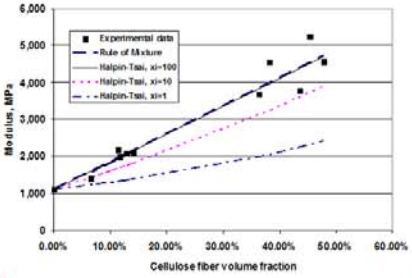
DMA: Storage Modulus of the Different Composites at 37°C



Fiber Volume Fraction Analysis in the Different Composites

Composite Reinforcement Fiber and AESO resin	Fiber Mat wt %	Flax or cellulose wt%	Resin and binder wt%	Fiber V%, based on Flax or Cellulose content
Pure AESO Resin	0.00%	0.00%	100.00%	0.00%
Cellulose 200, 84% Cellulose	19.1%	16.04%	83.96%	11.40%
Cellulose 150, 82% Cellulose	20.0%	16.40%	83.60%	11.67%
Flax Mat 85/15 20 oz, 85% flax	23.0%	19.55%	80.45%	14.06%
Flax Mat CCF300C, 40% flax	23.5%	9.40%	90.60%	6.53%
Flax Mat 60/40, 60% flax	30.0%	18.00%	82.00%	12.88%
Rayfloc XJE, 100% Cellulose	45.9%	45.90%	54.10%	36.36%
Rayfloc JLDE, 100% Cellulose	47.8%	47.80%	52.20%	38.14%
CTMP Pulp, 100% Cellulose	53.4%	53.40%	46.60%	43.55%
Recycled Paper, 100% Cellulose	55.2%	55.20%	44.80%	45.34%
Porosanier HP, 100% Cellulose	57.7%	57.70%	42.30%	47.88%

Composites Rule of Mixtures and Halpin-Tsai Fitting as a Function of Cellulose Content



Conclusions

1. Natural composites were successfully made out of soy oil based resin and natural fiber mats using vacuum assisted resin transfer molding process (VARTM).
2. Storage modulus of the soybean oil resin improved to more than 5 times with recycled paper.
3. Recycled paper is a cheap source of cellulose fiber and was successfully impregnated with AESO.
4. These natural composites were found to have mechanical strength suitable for applications such as housing and automotive.

Acknowledgements

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