Opportunities in Natural Fiber Composites

Lucintel Brief
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- Natural Fiber Composites Market Overview
- Natural Fiber Composites Competitiveness and Market Opportunity
- Market Trends and Opportunity
- Growth Opportunities in 2011 and Beyond
- Conclusions
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Executive Summary

• Global natural fiber composites market reached $2.1B in 2010, with compound annual growth rate of 15% in last five years

• Automotive & Construction were largest segment among all natural fiber composite applications
  • Bast fiber such as flax, Kenaf, hemp, etc. were the material of choice for automotive, whereas wood plastic composite was most preferred by building and construction players

• North American natural fiber composites market was the largest for wood plastic division whereas European region was leader in automotive segments– driven by Government support, environmental regulations, and customer acceptance

• By 2016, natural fiber composite market expected to reach $ 3.8B (10% CAGR)
  • Rising prices of petroleum based products, strong government support to eco-friendly products, higher acceptance and positive growth of end use industries, new housing numbers will drive natural fiber composites growth to new horizon
  • Performance improvement in materials will drive growth for natural fiber composites in new application areas
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Evolution of Natural Fiber Composites: Henry Ford developed first car with hemp fiber but due to economic limitations did not enter the market. Clay/mud reinforced composites, Fuselage skins of spitfires, Prototype composite car by Henry Ford, Body of “Trabant” car in Germany, Number of Automotive applications, E&E: Cases of cellular phones, Sporting goods.

<table>
<thead>
<tr>
<th>Applications</th>
<th>Materials</th>
<th>Time Frame</th>
<th>Materials</th>
<th>Time Frame</th>
<th>Materials</th>
<th>Time Frame</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Straw</td>
<td>3000 year ago</td>
<td>Flax+ Phenolic</td>
<td>1939</td>
<td>Hemp</td>
<td>1942</td>
</tr>
<tr>
<td></td>
<td>Flax+ Phenolic</td>
<td>1939</td>
<td>Hemp</td>
<td>1942</td>
<td>Cotton + Polyester</td>
<td>1950-1990</td>
</tr>
<tr>
<td></td>
<td>In Egypt clay/mud reinforced by straw to build walls.</td>
<td>1939</td>
<td>Shortage of Aluminum in England, led to use natural fiber</td>
<td>1950-1990</td>
<td>Flax, Hemp, kenaf, Abaca</td>
<td>2000 onwards</td>
</tr>
<tr>
<td></td>
<td>First production car built from Natural fiber composites</td>
<td>1950-1990</td>
<td>Flax, Hemp, kenaf, Abaca</td>
<td>2000 onwards</td>
<td>Kenaf + PLA</td>
<td>2004 onwards</td>
</tr>
<tr>
<td></td>
<td>2006 onwards</td>
<td>Flax, Hemp, kenaf</td>
<td>Flax, Hemp, kenaf</td>
<td>2006 onwards</td>
<td>Flax, Hemp, kenaf</td>
<td>Flax, Hemp, kenaf</td>
</tr>
</tbody>
</table>

In Egypt, clay/mud reinforced by straw to build walls. Shortage of Aluminum in England, led to use natural fiber. First production car built from Natural fiber composites.
Reinforced Natural Fiber Classification: Vegetable fibers are used as reinforced material, divided into two segments wood and non-wood fibers.
Natural Fiber Composite Applications and Technologies

Automotive
- Door panels
- Seat backs
- Headliners
- Dash boards
- Trunk liners
- Compression Molding
- Injection Molding

Electrical & Electronics
- Mobile cases
- Laptop cases

Sporting Goods
- Tennis Racket
- Bicycle Frames
- Snowboards
- Oven Cure

Construction
- Door panels
- Decking
- Railing
- Window frames
- Extrusion
- Compression Molding
- Injection Molding

Creating the Equation for Growth
Competitive Analysis: Natural fiber composites v/s glass fiber composites

- Natural fiber composites excel in most parameters except strength, strength of glass fiber composites is higher compared to natural fibers.

- Flax fibers offer the highest reinforcing potential amongst the other natural fibers.
- Flax offers higher tensile strength compared to others making it suitable for composite applications.

Source: Lucintel
### Performance Price Comparison of Competing Materials for Automotive Applications

<table>
<thead>
<tr>
<th>Materials</th>
<th>Average amount per car (lbs)</th>
<th>Performance/Price ratio (Specific strength/$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Steel</td>
<td>2000</td>
<td>0.15</td>
</tr>
<tr>
<td>Aluminum</td>
<td>600</td>
<td>0.08</td>
</tr>
<tr>
<td>Glass Fiber Composites (FRP)</td>
<td>77</td>
<td>0.36</td>
</tr>
<tr>
<td>Natural Fiber Comp.</td>
<td>35.2</td>
<td>1.15</td>
</tr>
</tbody>
</table>

Significant performance at lower prices of natural fiber composites, creating huge potential to replace competing materials in Automotive applications.

Source: Lucintel
Performance Price Comparison of Competing Materials for Automotive Applications

<table>
<thead>
<tr>
<th>Materials</th>
<th>Average amount per car (lbs)</th>
<th>Performance /Price ratio (Strength/$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Steel</td>
<td>2000</td>
<td>1.1</td>
</tr>
<tr>
<td>Aluminum</td>
<td>600</td>
<td>0.2</td>
</tr>
<tr>
<td>FRP</td>
<td>77</td>
<td>0.7</td>
</tr>
<tr>
<td>Natural Fiber Comp.</td>
<td>35.2</td>
<td>1.5</td>
</tr>
</tbody>
</table>

Natural fiber composites has superior price performance optimization

Source: Lucintel
Composites (fiber reinforced plastics – glass and carbon fiber based) Penetration in Various Market Segments: Natural fiber composites have significant potential in transportation and construction market

<table>
<thead>
<tr>
<th>Market Segment</th>
<th>Composite Materials Market</th>
<th>Structural Materials Market (Steel, Al &amp; Composites)</th>
<th>Composites Penetration</th>
<th>Performance Gap</th>
<th>Price Gap</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transportation</td>
<td>$2.7 B</td>
<td>$75.7 B</td>
<td>3.6%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Marine</td>
<td>$0.5 B</td>
<td>$0.7 B</td>
<td>68%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Aerospace</td>
<td>$2.0 B</td>
<td>$19.1 B</td>
<td>10%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pipe &amp; tank</td>
<td>$2.1 B</td>
<td>$29.6 B</td>
<td>7%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Construction</td>
<td>$3.1 B</td>
<td>$78 B</td>
<td>4%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wind Energy</td>
<td>$2.0 B</td>
<td>$5.4 B</td>
<td>38%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Consumer Goods</td>
<td>$1.1 B</td>
<td>$7.7</td>
<td>14%</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Composites Penetration compared to Competing Materials (Steel & Al)

Source: Lucintel
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External Forces Shaping the Natural Fiber Composites Industry: Future higher market fragmentation expected due to emerging economies. Companies in Developed nations with innovation capability can thrive and gain share.

Customers
- Awareness towards green products
- Global platforms
- Technical service
- Partnership
- Application development

Suppliers
- Specialization
- Efficiency
- Quality enhancement
- Uniformity in fibers
- Strategic sourcing

Competitors
- Competition from traditional material markets
- Focus/specialization

Workforce
- Skills
- Availability
- Location
- Proper utilization

Distributors
- Technical Service
- Specialization
- Efficiency
- Value-added

Regulators
- Directives on waste and recycling
- Legislative on carbon reduction
- Tax credits on renewable
- Government programs for natural products

Technology
- Innovation
- Performance improvement
- Process improvement
- Capital

Natural Fiber Composites Industry

Catastrophe
- Natural disaster
- Global recession
- Political instability

Awareness towards green products, Global platforms, Technical service, Partnership, Application development.
Natural Fiber Composites Trend and Forecast 2005 - 2016

**Key Insights**

- Natural fiber composites has experienced healthy growth in last five years
- Natural fiber composites market is divided into two segment - wood fiber and non-wood fibers
  - Automotive is the largest segment for non-wood fibers, whereas construction is for wood fibers
- Europe is the largest region for Automotive applications and North America is the largest region for Building & Construction applications
- Natural fiber composites are new materials for E&E and Sporting goods applications
- Environmental concerns are making natural fiber composites suitable in various new applications

**Notes:**

- Market includes wood and non wood natural fiber composites market

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**Natural Fiber Composites Trend & Forecast 2005 – 2016 ($M)**

<table>
<thead>
<tr>
<th>Year</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>2005</td>
<td>1,086</td>
</tr>
<tr>
<td>2010</td>
<td>2,171</td>
</tr>
<tr>
<td>2016</td>
<td>3,805</td>
</tr>
</tbody>
</table>

Source: Lucintel
Trend in GDP in Various Regions: 2005 - 2010

Natural Fiber Composites has observed positive growth in each region, and surpassed GDP growth.

Natural Fiber Composites industry performed well compare to GDP during last 5 years, and it is expected to continue to grow at a higher rate than GDP over the next 5 years.

Source: Lucintel

Notes:
- Others includes Asia and rest of the world
- Bubble size represents market size 2010 (M)
Natural Fiber Composites Potential in Different Regions

Market Leader:
- North America is the leader in the natural fiber composites consumption followed by the European region.

Potential Market:
- European region is potential region due to increasing awareness and acceptance of natural fiber composites by automotive players.
- Asian region have significant potential for growth of composites as composites per capita is significantly lower than developed nations.

Notes:
- Others includes Asia and rest of the world.
- Bubble size represents market size 2010 ($ M).

Source: Lucintel
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<td>• About Lucintel</td>
</tr>
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Creating the Equation for Growth
Creating the Equation for Growth

Growth Opportunities of Natural Fiber Composites in various Applications

Key Insights

- Demand for natural fiber composites is expected to be high in automotive and construction applications due to
  - Awareness towards green product and increasing acceptability
  - Need of light weighted cost effective products
  - Reduce global warming effect
  - Governmental supports
- As natural fiber composites are new in E& E and sporting segments, but it has healthy potential to capture a good market in near future

Source: Lucintel
Emerging Trends in the Global Natural Fiber Industry

Trend A: Increasing emphasis on recyclability

Trend B: Penetration of Wood Plastic Composites in North America

Trend C: Price-performance balance of Natural Fiber Composites

Trend D: Global concern towards global warming

Trend E: Asian Companies interest towards green electronics

Trend F: High demand of natural fiber composites by European Automotive Players
Eco Mobile by NEC 2006:
- First time in world an environmentally sound material has been used for a mobile phone casing

Model Name:
- “FOMA(R) N701iECO”

Material used:
- Reinforcement: Kenaf
- Resin: Poly Lactic acid

Advantages
- Heat resistant
- Environment friendly

Innovations in Automotive:
1. OEM & Model Name:
   - Ford Motor Co., 2010 FordFlex CUV

Applications:
- Trim bin

Material & Process:
- Wheat-Straw-Reinforced PP, Injection molding

2. OEM & Model Name:
   - BMW 2008MY BMW 7 Series Luxury Sedan

Applications:
- Door Panel

Material & Process:
- Prepreg of Natural fiber with acrylic polymer, Compression molding

3. Process Innovation
   - Highly automated D-LFT process by Daimler Chrysler

Racing Bicycle with NFC:
- Museeuw Bikes has developed first racing bike with flax carbon epoxy prepreg

Model Name:
- MF1, MF3, MF5

Material used:
- Reinforcement: Flax, Hemp
- Resin: Epoxy

Advantages
- Good anti-vibration property
- Low cost
### Emerging Natural Fiber Composite Applications in Automotive

<table>
<thead>
<tr>
<th>Applications</th>
<th>Fiber</th>
<th>Size of Opportunity</th>
<th>Key Drivers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Door panel/inserts</td>
<td>Kenaf/ Hemp</td>
<td>Medium</td>
<td>• Lighter weight</td>
</tr>
<tr>
<td></td>
<td>Wood fiber</td>
<td></td>
<td>• Lower cost</td>
</tr>
<tr>
<td>Rear parcel shelves</td>
<td>Kenaf</td>
<td>Medium</td>
<td>• Eco friendly</td>
</tr>
<tr>
<td></td>
<td>Flax</td>
<td></td>
<td>• Governmental support</td>
</tr>
<tr>
<td>Seatbacks</td>
<td>Flax</td>
<td>Medium</td>
<td>• Friendly processing</td>
</tr>
<tr>
<td>Spare tyre covers</td>
<td>Flax</td>
<td>Medium</td>
<td>• Thermal recycling is possible</td>
</tr>
<tr>
<td>Other interior trim</td>
<td>Kenaf/ Flax</td>
<td>Small</td>
<td>• Good thermal and acoustic insulating properties</td>
</tr>
<tr>
<td>Spare-wheel pan</td>
<td>Abaca</td>
<td>Medium</td>
<td></td>
</tr>
</tbody>
</table>

**Door Panel**  
**Interior Door Panel**  
**Door Inserts**  
**Interior Panels**  

**Creating the Equation for Growth**
# Emerging Natural Fiber Composite Applications in Construction

<table>
<thead>
<tr>
<th>Applications</th>
<th>Fiber</th>
<th>Size of Opportunity</th>
<th>Key Drivers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Decking</td>
<td>Wood, Flax, Rice husk, Bagasse</td>
<td>High</td>
<td>• Lower life cycle cost</td>
</tr>
<tr>
<td>Railing Systems</td>
<td>Wood, Flax, Rice husk, Bagasse</td>
<td>High</td>
<td>• Low &amp; easy maintenance</td>
</tr>
<tr>
<td>Window frame</td>
<td>Wood, Flax, Rice husk, Bagasse</td>
<td>High</td>
<td>• Low moisture absorption</td>
</tr>
<tr>
<td>Fencing</td>
<td>Wood, Flax, Rice husk, Bagasse</td>
<td>Medium</td>
<td>• Lower variability than wood</td>
</tr>
<tr>
<td>Panels</td>
<td>Wood, Flax, Rice husk, Bagasse, coir, stalk</td>
<td>High</td>
<td>• Eco friendly</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Governmental regulations</td>
</tr>
</tbody>
</table>
## Emerging Natural Fiber Composites in Other Applications

<table>
<thead>
<tr>
<th>Applications</th>
<th>Fiber</th>
<th>Size of Opportunity</th>
<th>Key Drivers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tennis Racket</td>
<td>Flax</td>
<td>Medium</td>
<td>• Good anti vibration</td>
</tr>
<tr>
<td>Bicycle Frame, Fork, Seat Post</td>
<td>Flax</td>
<td>Medium</td>
<td>• Lower cost</td>
</tr>
<tr>
<td>Snowboarding</td>
<td>Hemp</td>
<td>Small</td>
<td>• Eco friendly</td>
</tr>
<tr>
<td>Mobile Cases</td>
<td>Kenaf</td>
<td>Medium</td>
<td></td>
</tr>
<tr>
<td>Laptop Cases</td>
<td>Flax</td>
<td>Medium</td>
<td></td>
</tr>
</tbody>
</table>

**Laptop Cases**

**Musical Cases**

**Bicycle with NFC frame**

**Tennis Racket**

**Snowboard**

*Creating the Equation for Growth*
## Natural Fiber Composites Market Potential Analysis in Automotive in 2015

<table>
<thead>
<tr>
<th>Applications</th>
<th>NFC Potential in 2015</th>
<th>NFC Potential Strength Improvement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Door Panels</td>
<td>145 M lbs</td>
<td>@ Current Strength</td>
</tr>
<tr>
<td>Door inserts</td>
<td>US$ 72 M</td>
<td></td>
</tr>
<tr>
<td>Shelves</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Spare wheel</td>
<td>234 M lbs</td>
<td>@ 25% Improvement</td>
</tr>
<tr>
<td>pan cover</td>
<td>US$ 117 M</td>
<td></td>
</tr>
<tr>
<td>Headliners</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bumpers</td>
<td>324 M lbs</td>
<td>@ 50% Improvement</td>
</tr>
<tr>
<td>Protection trim</td>
<td>US$ 162 M</td>
<td></td>
</tr>
</tbody>
</table>

Methodology: Sensitivity analysis between consumption volume & strength performance of natural fiber

Source: Lucintel
Conclusions

- New business models need to be re-invented to address the fast changing complex world
- Higher specific properties with lower prices of natural fiber composites are making it attractive for various applications
- Good anti-vibration properties & low cost are key drivers for higher adoption of natural fiber composites in sporting goods segment
- Due to lower life cycle cost & easy maintenance of wood plastic composites, it is gaining more acceptance in building & construction applications
- Eco-friendly measures taken by electronic companies are the major growth drivers for natural fiber composites in Electrical & Electronics applications
- Rising prices of petroleum based products, strong government support to eco-friendly products, higher acceptance and positive growth of end use industries will drive natural fiber composites growth to new horizon
- Performance improvement of natural fibers will help to cater more applications and industries in near future
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About Lucintel

- Lucintel is the leading global management consulting & market research firm.

- Lucintel creates your equation for growth and is committed to actionable results that deliver significant value and long term growth to our clients.

- Lucintel has been creating measurable value for over 10 years and for more than 1000 clients in 70 + countries worldwide.

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**Market Reports**
- Aerospace
- Transportation
- Marine
- Construction
- Renewable Energy
- Recreational
- Composite Materials

**Consulting**
- Growth and Strategic Consulting
- Benchmarking
- Opportunity Screening
- Partner Search and Evaluation
- Due Diligence and M&A
- Market Entry Strategy
Lucintel has an extensive toolkit to address key strategic questions for increasing your company’s profitability and market presence.

**Key Questions**

- Is market space / opportunity of current product offerings sufficiently robust?
- Markets are focus for many: how can my company profitably differentiate?
- Based on our core skills, where should we focus?
- Should we build or buy? Is build even an option?
- What game changer actions exist and/or is a more incremental approach best?
- What is the order sequence of market entry segments / products?
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