Bio-based Automotive Components

Biological Systems Engineering | VirginiaTech Invent the Future

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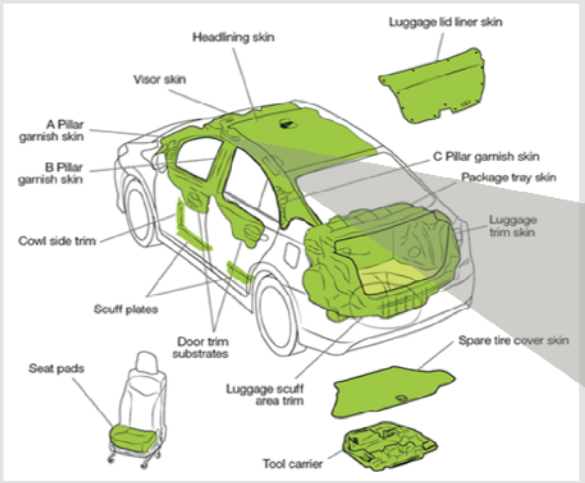
Introduction

Our design targets the issue of petroleum-based plastics being the dominant component in cars. Using keratin fiber derived from chicken feathers as a renewable source, we can take this common waste product and produce an alternative for automobile companies. Our product also seeks to reduce gas mileage by reducing the weight of the automobile.



Toyota Lexus HS bio-based car components

State of the Industry

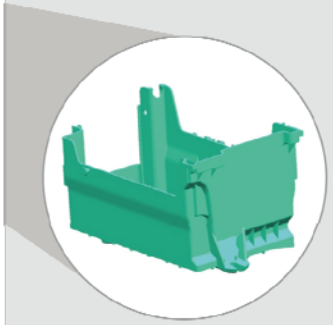
Automotive companies such as Toyota and Ford are moving towards more environmentally friendly products. Ford has set an example by greatly reducing its petroleum consumption by 2,300 tons and carbon dioxide emissions by 9,000 tons annually by incorporating bio-plastics.

Due to government mandates, the automotive industry in Europe is expected to increase the recyclability of materials used in the automotive industry to 85% by 2015.

Keratin feather fiber is a low cost additive that can be added to current plastics formulations to increase biobased content, decrease product density, and maintain or increase mechanical properties. The combination of hydrophobicity and hydrophilicity in the protein make it compatible with a host of plastics.

The Process

- Cleaned feathers are chopped into several millimeter long pieces
- Fibers are separated from the quill using a screen or air stream
- Feathers and polymer are fed into the extruder simultaneously to form pellets
- Pellets are then injected into a mold to create the desired part



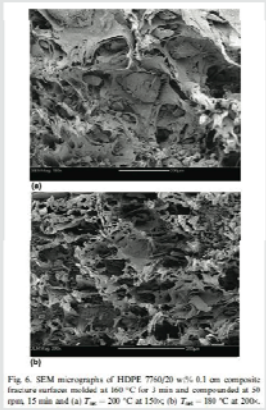


Fig. 6. SEM micrographs of HDPE 7760/20 w/% 0.1 um composite fracture surfaces molded at 160 °C for 3 min and compounded at 30 rpm, 15 min and (a) T_{ac} – 200 °C at 150x; (b) T_{ac} – 180 °C at 200x.

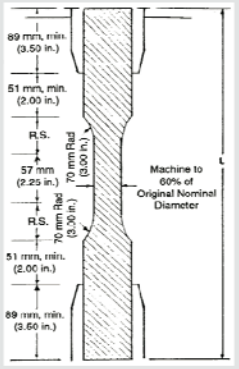
The Product

The initial effort to produce a part for the eco-car team led us to choose the battery tray over other parts because of its visibility when displaying the car. Furthermore, a simplified version was feasible to produce in the lab as it could be made without molding.

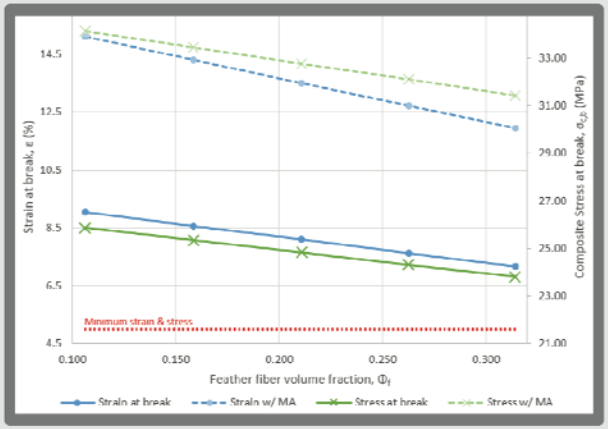
After comparing five different plastic resins through mathematical modeling, a High Density Polyethylene (HDPE) resin was selected due to its superior properties and low cost. At 30% keratin fiber content, the bio-plastic meets the mechanical properties required for a battery tray.

Standards

Due to production constraints, the material properties of the bio-plastic were the most critical part of the design. Tensile strength at break and strain are the key properties in regards to our product. D638-10 is the standard ASTM protocol for assessing tensile strength of plastic, which was the foremost issue to assess due to safety requirements for the car.



Strain and Stress vs Biobased Content



Conclusion

The graph above shows how the tensile stress and strain exceed the minimum required values. If certain parts require higher tensile stress or strain, maleic anhydride can be used to increase these properties. Incorporating 30% feather fiber composite would yield savings of approximately ¢28 per pound of raw materials.

After detailed scrutiny of the cost of production, ease of integration, safety, material design parameters and environmental impact for multiple auto components, it is evident that bio-plastics are superior.