

BIOASTRA

Smart | Protective | Circular

November 2024

2024-12-03

WHY POLYURETHANE ?

- ▶ Versatility: Fibres, Foams, Elastomers, Adhesives, Coatings
- ▶ Range of Foam Properties – Flexible, Rigid, Semi-Rigid, Spray
- ▶ Hydrophilic and Hydrophobic Options
- ▶ Ease of Manufacture
- ▶ Inert and Biostable
- ▶ Established Supply Chains and Production all over the World



WHY CONSIDER PU ALTERNATIVES ?

▶ **Safety Concerns**

- ▶ Critical Molecule: Isocyanate
- ▶ Emission of VOCs
- ▶ At least two medical device recalls.
- ▶ Other PU-enabled devices under scrutiny

▶ **PU Industry has a good reputation for product stewardship**

- ▶ **Guidelines for Isocyanate Handling and Exposure**
- ▶ **Need for Proper Ventilation**

▶ **Sustainability**

Petrochemical-Based
Non recyclable
Non biodegradable

▶ **Supply Chain**

- ▶ Fluctuating supply. Foam Crisis Supply in 2021 led to Production Stalling
- ▶ Lower Demand from Construction

THE PU ALTERNATIVES

- ▶ **Non-Isocyanate PU Foams**

- ▶ Several Companies, including Incumbents and Research Groups

- ▶ **Biobased PU Foams**

- ▶ Evoco

- ▶ **Rigid non-PU Biofoams**

- ▶ Cruz Foam (Chitin)
 - ▶ Fibre Tech (Pulp and Paper)

- ▶ **Flexible BioFoams**

- ▶ Bioastra

The BIOELASTOMER PLATFORM:

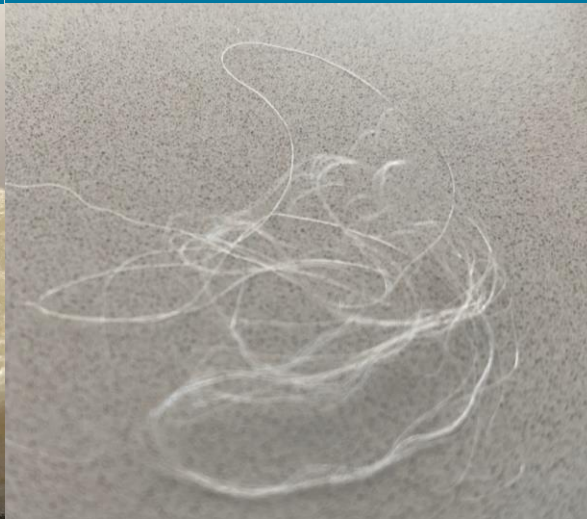
WORLD'S FIRST 100% PLANT-BASED REPLACEMENT FOR POLYURETHANE AND OTHER ELASTOMERS

- Bioastra's Bioelastomer Platform: Family of Materials with the same core chemistry, just like Polyurethane
- Replaces Polyurethane in all its Forms: Fibre, Foam, Adhesive, Thermoset and Thermoplastic Elastomer
- Rivals Polyurethane in Performance: High Elasticity and Modulus, Comparable Thermal & Acoustic Properties
- **Made ENTIRELY from 100% plant-based Natural Molecules.**
- Completely Biodegradable and Biocompatible.
- Can be Recycled via Dissolution

Bio-Foam



Stretch Fiber



Bioadhesive



Bioresin



Bioelastomer



Biofoam

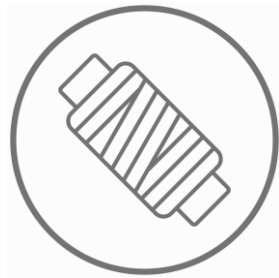


- ▶ Completely different Chemistry from Polyurethane
- ▶ Characteristics
 - ▶ Current Density: 0.06 /cm³
- ▶ 100% Biobased Foam
 - ▶ Key Ingredients: Citric Acid, Starch, Baking Soda, Castor Oil
 - ▶ USDA Certified Ingredients
 - ▶ Each component is Readily Biodegradable as per ECHA
 - ▶ Recycling and Reuse through Dissolution in biosolvent
 - ▶ Cost On par with PU flexible foam at comparable densities
 - ▶ Manufactured through Injection Molding, Casting and Pour Molding

FOUR PILLARS OF SUSTAINABLE PERFORMANCE

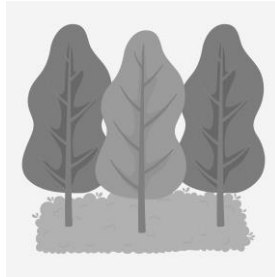
Performance

Matches performance of incumbent materials



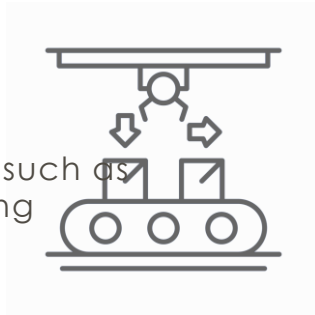
Feedstock

Made from bio-derived natural molecules



Manufacturing

Mass-produced using legacy manufacturing processes such as melt spinning and injection molding



End-of-Life Management

Can be indefinitely recycled in conventional facilities.
Biodegrades at the end of life



Commercialising New Foams/Materials: Lessons Learned

- ▶ Brands and OEMs, including Manufacturers of Incumbent Materials, are open to Sustainable Alternatives
 - ▶ PERFORMANCE FIRST!
- ▶ Consumer/Legislative Imperative for Transitioning to Sustainable Alternatives
- ▶ Critical to Successful Commercialisation and Adoption
 - ▶ Abundant Feedstock, Stability in the Supply Chain and Availability of Alternatives
 - ▶ Manufacturing New Materials in a Drop-in Manner (zero or minimal adjustments) using conventional lines
 - ▶ End-User/Market Pull
 - ▶ Path to Parity: Early Adopters are open to paying premium for launch volumes as long as there is a pathway to price parity in a 3 Year Horizon
- ▶ In Medical Applications, regulatory landscape discourages breakthrough materials innovations.
 - ▶ Majority of Class 1 Devices exempt from 510(k). Still needs biocompatibility/cytotoxicity tests
 - ▶ Updated CLAP guidelines helps streamline materials testing
- ▶ **IT TAKES A VILLAGE!**
 - ▶ Engaging the Entire Ecosystem from Raw Material Suppliers all the Way to Brands
 - ▶ Working together with Incumbents and Challengers Alike. Not pitting one against another