Sustainable Automotive Seating Materials – Design for Recycling

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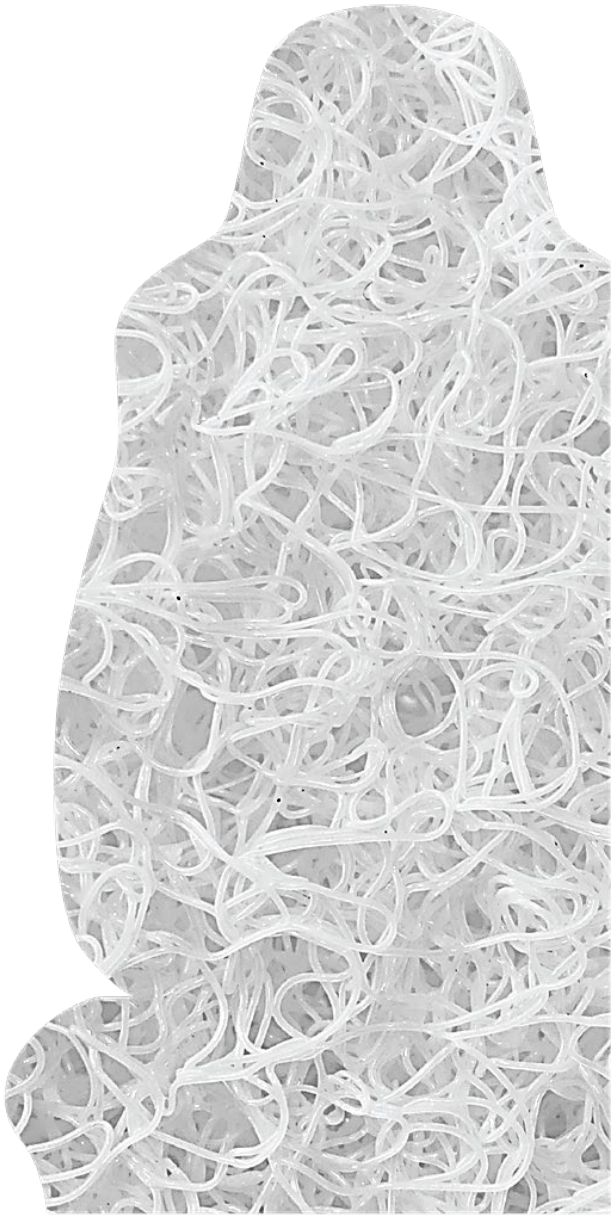


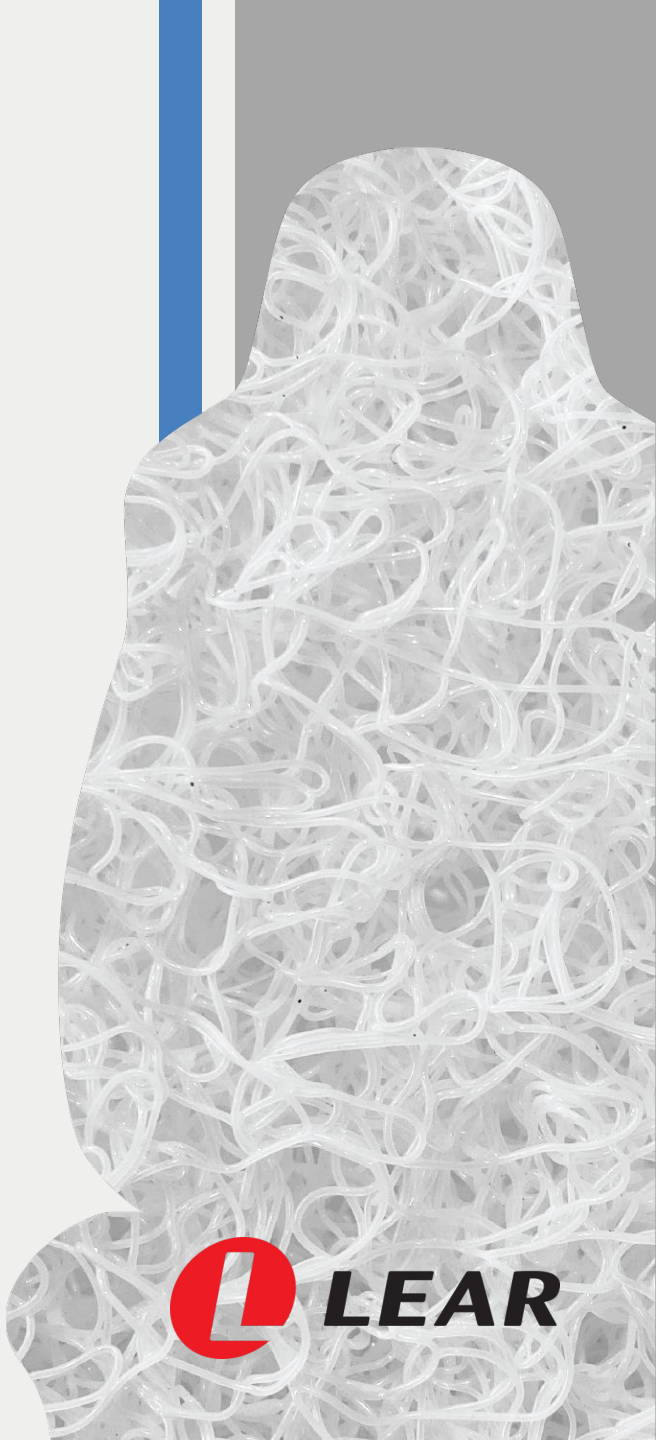
Improving Comfort with 100% Recyclable Technology

FLEXAIR™

FlexAir™ provides significant advantages, including:

- **Up to 50% reduction in CO2** emissions compared to traditional PU foam
- **100% recyclability** of complete pad assembly with integration of Lear proprietary trim fastener design
- 100% breathable material
- **Anti-microbial** and low VOC product properties
- Provides **improved comfort** performance

Lear has developed FlexAir™ for the automotive market and has been in production since January 2024

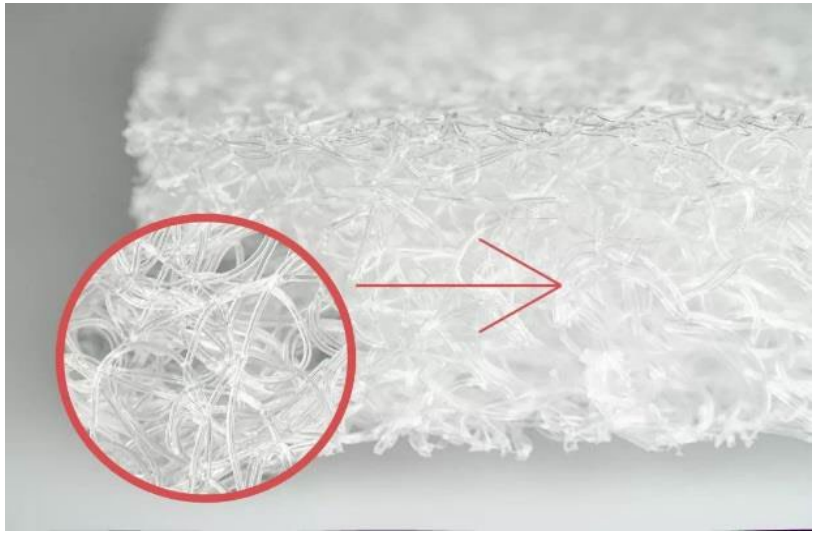


Dow INFINAIR™ Polyolefin Resins for 3D Loop Technology

Seek Together™

Characteristics

- Melt Index (190 °C, 2.16 kg): 10 – 30 dg/min
- Density: 0.88 – 0.95 g/cm^3



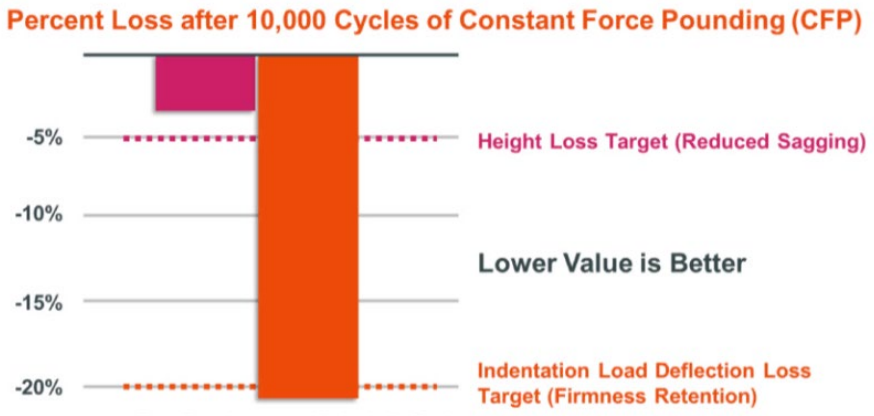
Features

- Uniquely designed for 3D loop cushion fabrication
- Rheology and molecular architecture for thin filament extrusion
- Balanced hardness and elasticity in 3D loop cushions

3D Loop Cushion Performance

- Hardness: varies depending on bulk density and thickness
- Rebound: 55 – 65%
- Hysteresis loss: 25 – 35%
- Compression set (70 °C, 50% strain, 22 h): 10 – 13%

Comparable to traditional PU foam



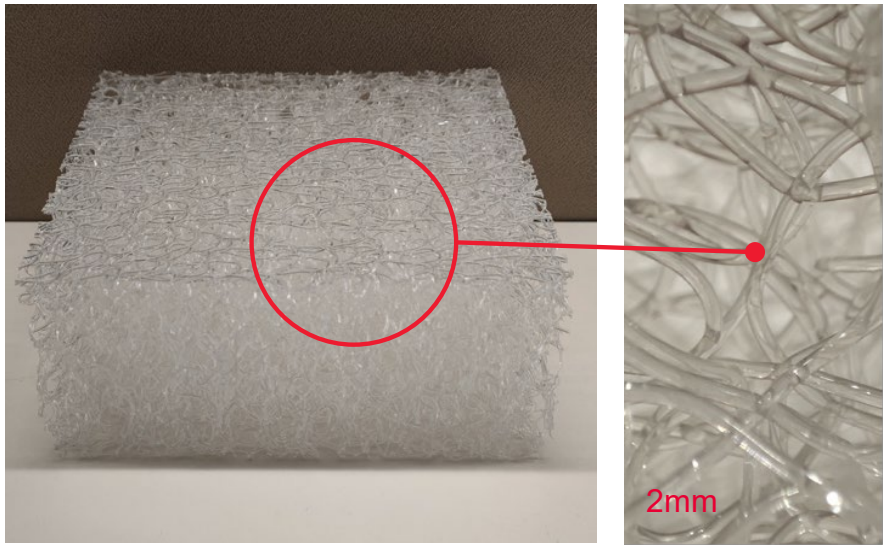
Dow INFINAIR™ Polyolefin Resins for 3D Loop Technology

Seek Together™

- 100% recyclable
- Low VOCs/Odor
- Breathable
- Excellent thermal management
- Washable
- Very low moisture retention

Infinair™
polymers for loop technology

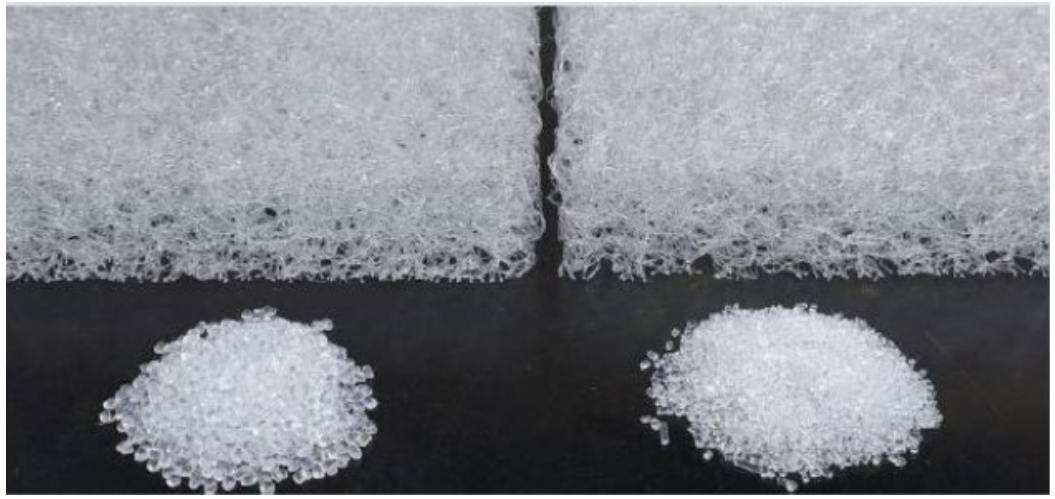
2021 R&D 100 FINALIST



Recycling of 3D Loop Cushioning

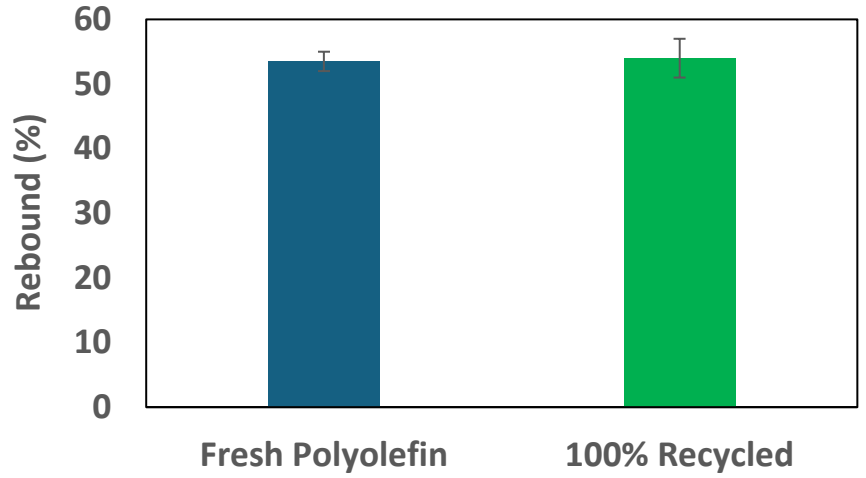
Seek Together™

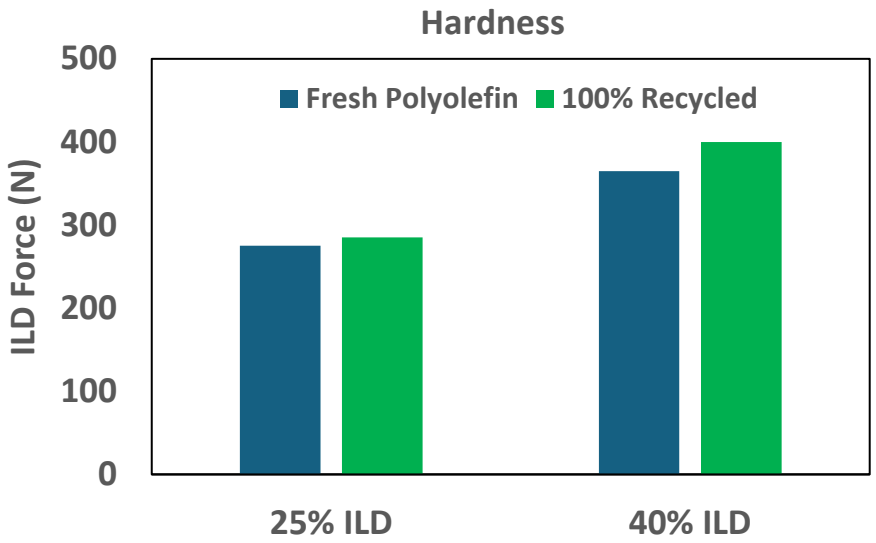
3D Loop to 3D Loop Recycling



Fresh polyolefin

100% recycled polyolefin





Fresh vs. Recycled Polyolefin 3D Loop

- 3D loop structure: Same
- Color: Same
- Rebound: Same
- Hardness: Minor change (< 10%)

Dow Bio-circular Polyolefin Products

Seek Together™

No direct/indirect change in land use

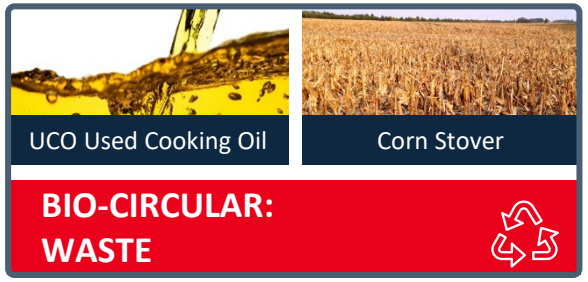
Lower carbon footprint vs. fossil-PE

No food/feed competition

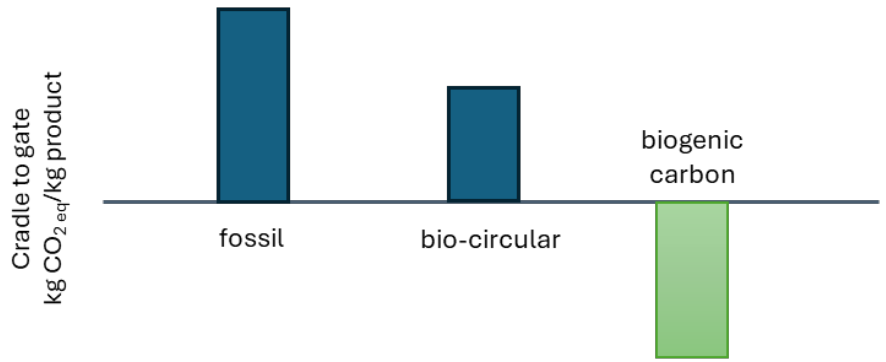
Using other industries' bio residues as raw materials helps to save fossil resources

Drop-in broad product portfolio: bio-LDPE, bio-LLDPE, bio-POEs/POPs

Value Proposition of bio-based plastics: lower carbon footprint & same performance



Example of Bio-circular vs fossil resin



Example only, not actual values

Bio-circular materials use atmospheric carbon vs. releasing carbon from the earth.

Products derived from bio-circular feedstocks are ISCC+ certified and based on mass balance

FlexAir™ Life Cycle Analysis (Cradle to Gate)

CO^2 produced for 1kg pad weight of FlexAir™: 2.3kg FlexAir™ vs 3.7kg Polyurethane Foam

- Cradle to gate analysis to produce **FlexAir™** involves measurement of CO_2 emissions at each stage, from raw materials and production processes
- In accordance with **ISO14040/ISO14044**
- Using average figures for energy, packaging & waste production for one seat studied in 2021
- LCA results in a 50% CO_2e savings

Cradle to Gate Includes:

- Production, Processing & Transportation of Raw Materials
- All manufacturing inputs: Extrusion, Cutting, Molding
- Energy – Gas, Electric, Water
  Auxiliary Materials, Waste

	FlexAir™	PU Foam
Front Driver 65kg/m^3 foams	5.3kg CO_2e	10.8kg CO_2e
3rd Row Seat Cush - 45kg/m^3 Back - 50kg/m^3	5.01kg CO_2e	6.01kg CO_2e
Sedan Seatback 45kg/m^3	2.78kg CO_2e	4.57kg CO_2e

All values are estimated

FlexAir™ savings of 17-50% CO_2e per kg pad weight

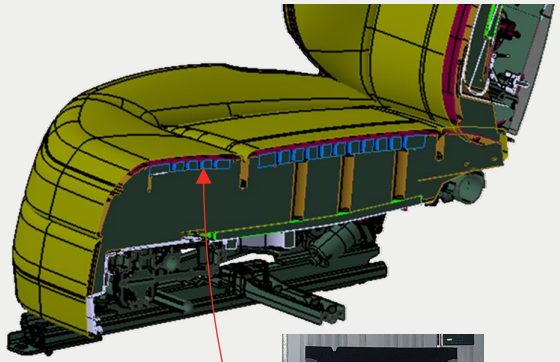
FlexAir™ Testing

Test Name	Method
Ingress/Egress	100,000 cycles
Jounce	7,500 – 1,000,000 cycles (seat/row dependent specs)
Load Floor Permanent Set	Ambient, low temp, high temp
BSR, Sound Quality	Standard buzz, squeak, rattle
Comfort testing	H-point, dynamic comfort, pressure mapping
Knee Load	100,000 cycles
Side AirBag Deployment	Ambient, low temp, high temp
Flammability	FMVSS302
VOC, Fogging, Odor	Passed to multiple OEM

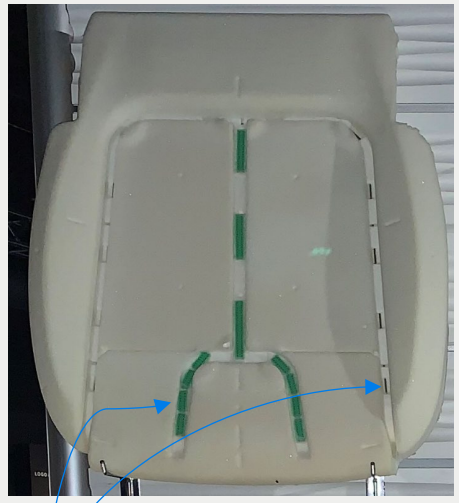
400+ tests completed with FlexAir™

Industry Challenges

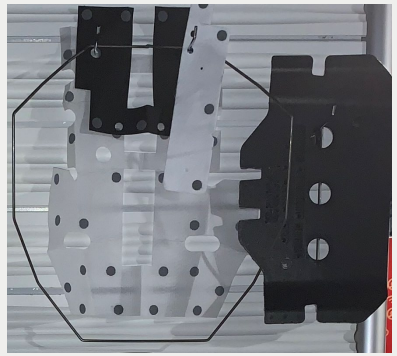
- Incorporating recycled materials
  - Availability
  - Durability / lifecycle changes
  - Specification revisions
- Design for automated assembly
- Design for Disassembly to support recyclability & circularity goals



Air distribution bags, heater mats, cut foams, sensors



Trim retainer clips, wires, hook strip



In-molded cloths, wires, carpet, stiffeners

Difficulty to recycle foam due to in-molded components → majority are landfilled

Fresh Start with FlexAir™

FlexAir™ advantages

- ✓ Dow's Bio-circular polyolefin
  - ✓ Available on market today
- ✓ Validated at material & seat complete levels
- ✓ Designed for Automated Assembly
- ✓ Designed for Disassembly
- ✓ Designed for Recycling
- ✓ Designed for Circularity

Adopting new materials offers sustainable solutions, along with opportunities to innovate manufacturing methods

Conclusion

- Lear & Dow are working together to bring sustainable products to market that offer win-win solutions to the OEM customer
- Polyolefin products specifically designed for 3D loop cushioning application with bio-circular options
- FlexAir offers a sustainable solution that maintains comfort and durability of traditional PU foam like no other solution on the market
- We all need to work together, as an industry, to support recycling and circular industrial partners and processes to reduce waste

Innovation and collaboration lead to industry evolution


LEAR
Thank you!
Reduce . Reuse . Recycle
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