CARE Market Development Update

CARE National Conference

May 1, 2019

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Verdex Technologies
Non-Woven Institute
General Market Update

CARE National Conference

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Verdex Technologies

Verdex Technologies

Development Overview

Verdex developed proprietary Nozzle Technology to produce fibers in a single step into Non-Wocen webs.

Suited for Contaminated Polymers Because Tech. does not depend on small orifice holes to make fibers.

Suited for degraded Polymers such as P.C. PET fibers with low fiber strength which ordinarily would not be able to be spun.

Nozzle creates Aerodynamic Entanglement during web formation.

Development Update

Details.

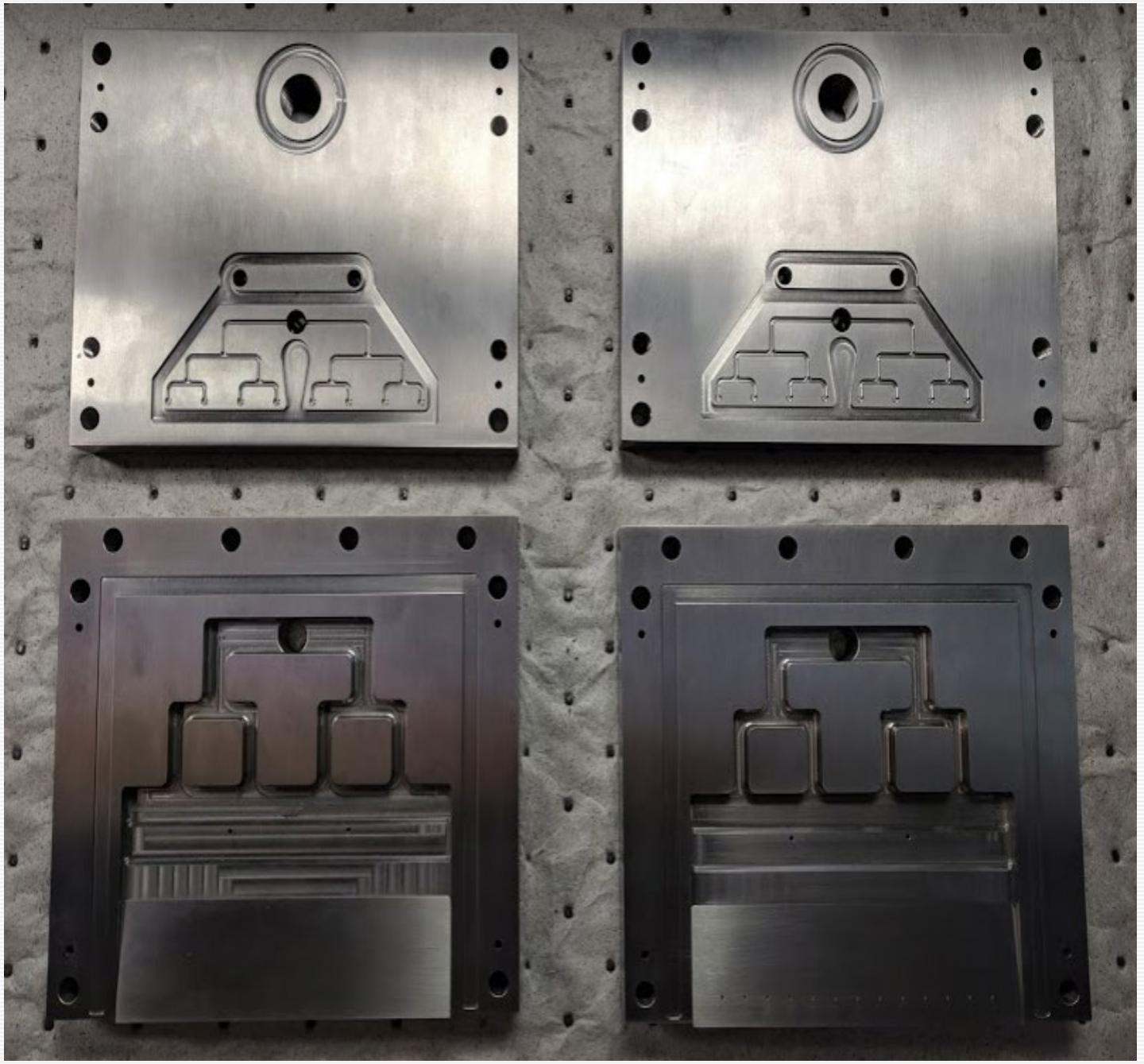
- CARE Grant allowed resources for nozzle commercialization
- Nozzle development Complete and Testing Web Testing under way.
- Verdex has finished work to define Orifice size and array for spinning Recycled PET Stream.
- Several Versions of contaminated PET have been delivered and trialed.
- Ash contamination in the 3% to 5% range is acceptable. PP contamination can be as high as 10%.
- Multi-Orifice Nozzle Array is being built with Grant funds for Commercial Development.

Nozzle Details.

Array of Entangled fibers
Spinning from
new Verdex Orifice

Next Steps

Newly Designed Nozzles



Next Steps

Scale-up

Potential Markets

Verdex Expects to be spinning Recycled PET carpet fibers in May 2019 with Proprietary Scale-Up Spin Nozzle.

Three Non-Woven Markets have been Identified

1. **Acoustics - Verdex Non-woven Fibers Sandwiched between 2 layers of Virgin Spunbond.**

   Samples made and tested more efficient than incumbent Products for Automotive uses.

2. **High Efficiency Air Filtration. PET Nano Fibers Deposited on a Pleatable Spunbond Substrate.**

   Samples made and Texting in Progress.

3. **Cable & Wire Wrap. PET fibers with Super Absorbent Polymer Particles on a Spunbond Substrate.**

   Samples to be made.

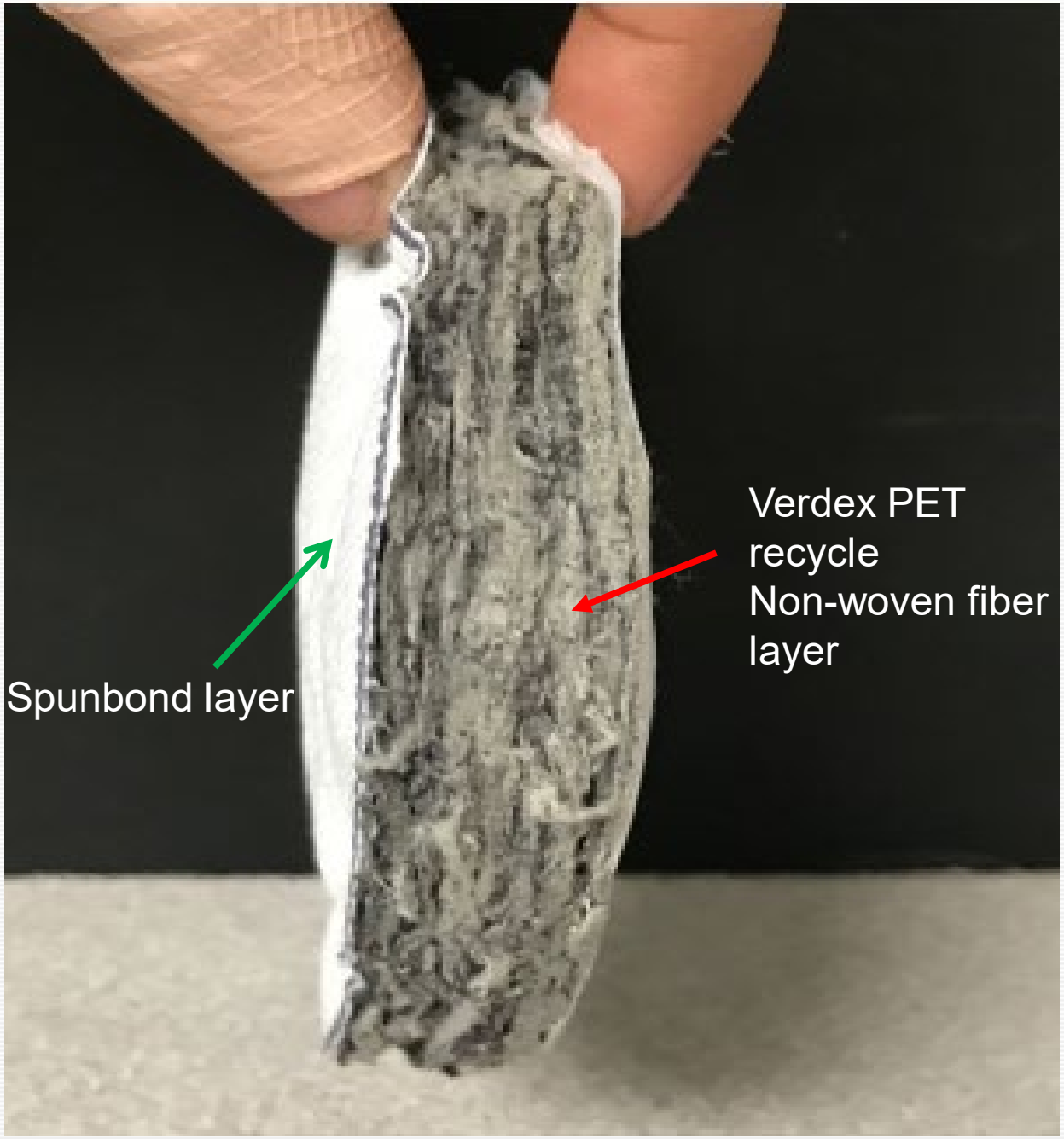
Market End Use

Acoustic Market

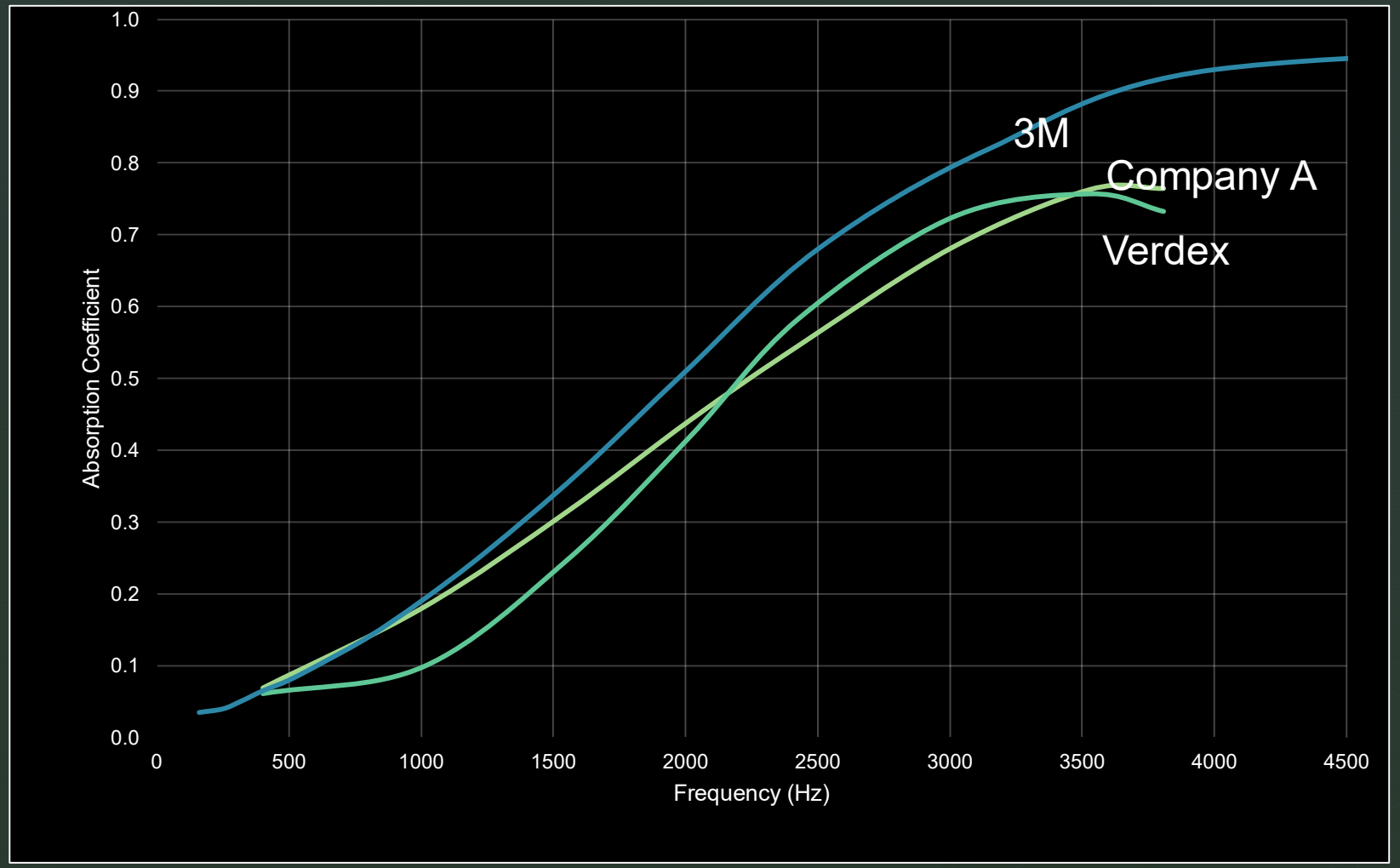
Verdex PET Nanofiber to be Added to the Inside of Acoustical Blanket

Market End Use

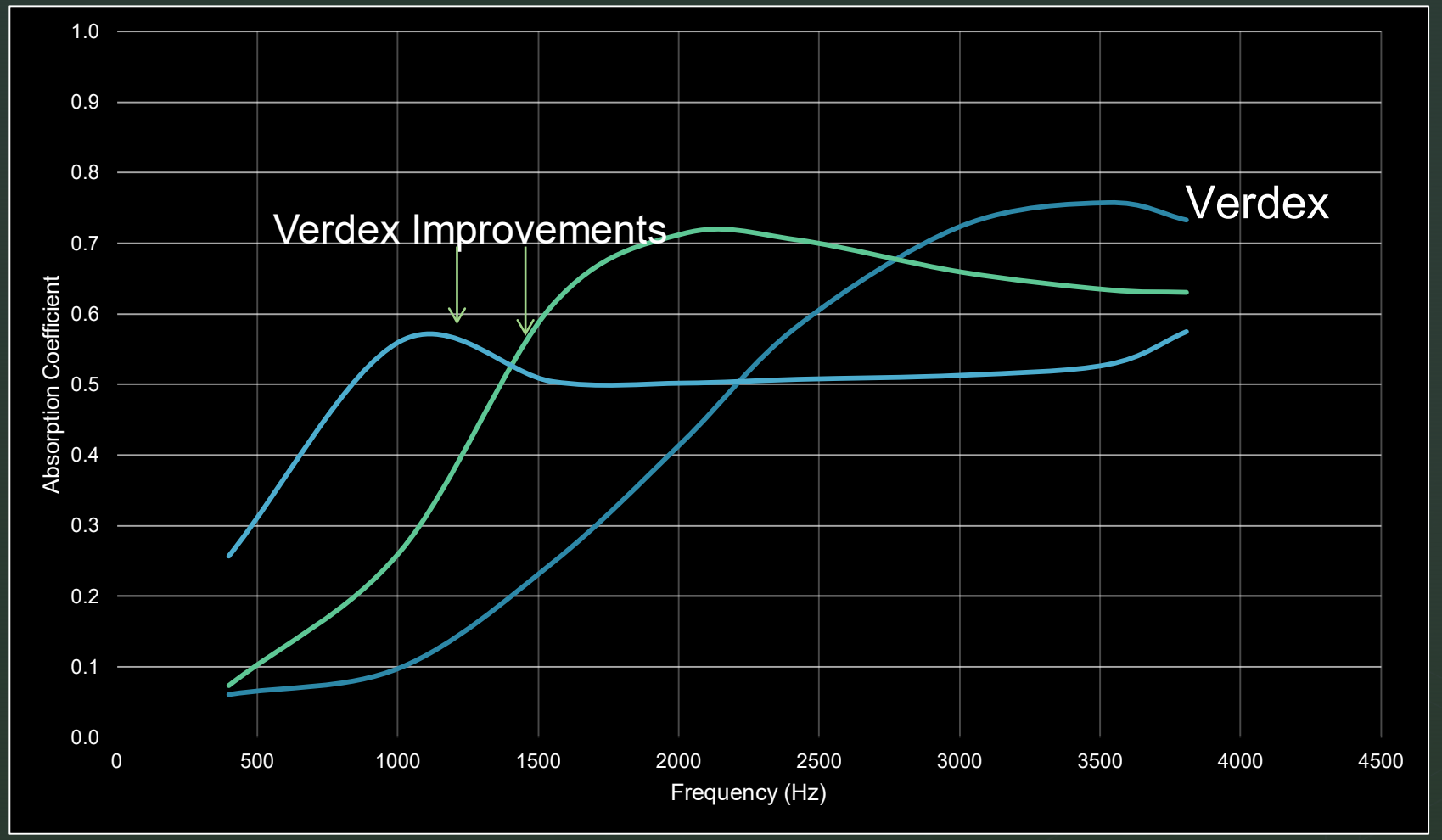
Acoustic Market



Acoustical Absorption of Verdex vs. Incumbents



Verdex Improvements
Low Frequency Sound Absorption



CARE Market Development Update

Non-Woven Institute (NWI)
Non-Woven Development

CARE Annual Conference

May 1, 2019

Objectives of Development

- **Long Term Project**
- **Study all Potential P.C PET Candidates for Non-Wovens**
- **3 Phases of Study**
  - Characterization
  - Fiber Formation Trials
  - Applications Market Development

P.C. PET Characterization

- **A Dozen Streams from the Marketplace were Considered**
  - Minimally processed >>>> Cleanest.
- **How did each stream Perform in its Fiber making Ability**
  - Could any, or all, make non-woven Fabrics
  - Which Manufacturing methods could be used
  - Which process parameters to use: Temp., press, flow rates, etc.
  - Hundreds of permutations and Combinations

PC. PET Characterization

- **Eventually 3 versions were chosen**

Recycled Streams Dirty >>>> Clean

Materials Considered	Impurity Levels	
Rec PET grade 1	~15% ash	~20%PP
Rec PET grade 2	~6% ash	~20% PP
Rec PET grade 3	2% ash	2% PP
F61 (virgin)	No impurities	

Key to Success: Fiber Strength

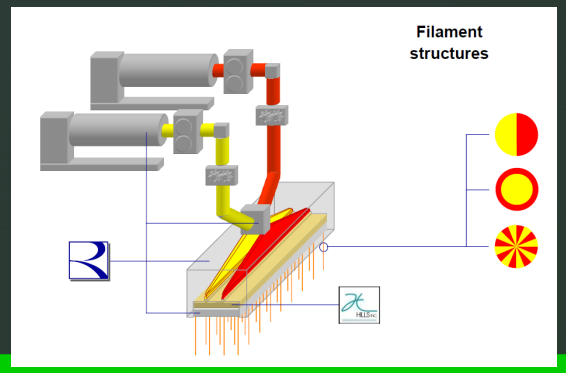
Recycled Carpet Stream	Intrinsic Viscosity
Rec PET Grade 1	0.41 (38% low)
Rec PET grade 2	0.49 (26% low)
Rec PET grade 3	0.54 (18% low)
Virgin Indorama PET	0.66

Fiber Strength Variations

Within Each Recycled Stream Type: Great Variations

- **IV Changes from one sample to next – Why ?**
  - Varying degrees of Degradation from Age
  - Samples could be 2 years old; or Decades Old
  - PET made 20 yrs. Ago is not same as today
  - Unseen or unknown Contamination

Non-Woven Fiber Formation Methods

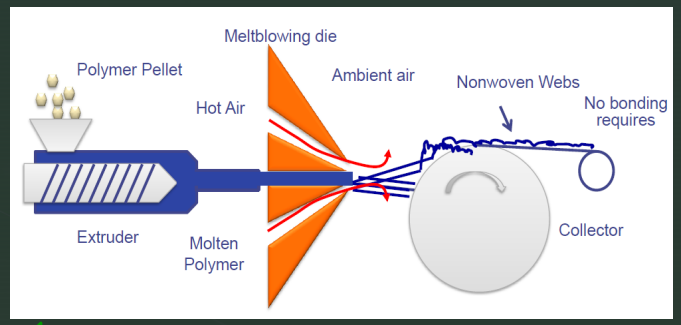


Bi-Component Filament Extrusion

Multi-functionality of 2 polymers simultaneously

Can process low viscosity and poor melt strength polymers

Applications: Medical & Hygiene products, Filtration, **Industrial Wipes**, **Automotive, Carpets, Geotextiles**, etc.



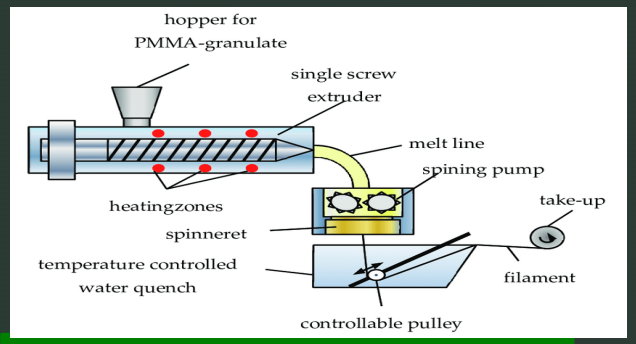
Melt-Blowing

Can process low viscosity and low melt strength polymers

Economical way to produce finer fibers

Diverse range of raw materials

Applications: Medical & Hygiene products, Filtration, **Construction, Packaging**, etc.



Homo-component Fiber Extrusion

Cost-effective & simple

High-speed of production

Staple fiber & continuous filament production, with drawing process (increases tensile strength)

Applications: **Apparel, clothing and shoe industry**, Medical products, **Protective wear**, etc.

Non-Woven Web Formation Trials

- **Filament Spinning – Dozens of Variations - Not Viable**
  - 100% & variety of Blends
- **Biax Melt Blown System – Dozens of Variations - Not Viable**
  - 100% & variety of Blends
- **Bicomponent Spinning**
  - Next Work Scheduled week of May 5, 2019

Technical Path Forward Q2 2019

- **Bicomponent Spinning**
  - Has best chance of Success
- **Trials Scheduled w/o May 5, 2019**

Why Bi-Component Spinning

This process is much more forgiving. The recycled PET pellets will be used as the CORE, where lower IV, low melt strength and contamination levels are less critical. Virgin PET with high Strength will be used in the SHEETH engulfing the Core with high strength material.

Development Summaries to Date

Completed

- TGA –Thermographic
- DSC Scaning Calorimeter
- MVR – Melt Flow
- Web formation trials on Spunbond line
- Web formation trials on the Biax line

Partially completed

- Solution Viscometry (for IV)
- FTIR (compositional analysis)
- GPC (MW analysis)
- Fiber spinning trials on the Hills Homo-component line - Canceled
- Fiber Spinning trials on Bi-component line – To Come

Initial Market Interest In NWI Technology: INDA Non-Woven Show

Company Name	Contact Person	Region	Notes
Nagreeka Exports Ltd.	Aditya Patwari	Mumbai, India	Interested in recycled polymers – PET (mostly bottle)
Foss Performance Materials	Bill Cummings	Hampton, NH, USA	Interested in recycling process
Auria Solution	Ernie Wilson	Albemarle, NC, USA	Recycling and sustainability, use in nonwovens
Blachford Acoustics Group	Alex Rak	Cambridge, ON, Canada	Interested in recycling of PET
Brunson Recycling	Megan Sharp	Matthews, NC, USA	Interested in recycling of PET bottles and carpet, nonwoven product development

Full Market Development

- **To Begin toward End of Technical Work after all specifications have been developed.**
- **Slated to begin Q4 2019.**

All Fibers Recycling Update

General National Development

Fiberon

- Minnesota Plant in Startup mode
- Plant has been Retooled for new **PET** Products.
- Equipment changes have delayed production.
- Expect Volume of PET recycling in 2019
- High Volume Expected when in full Operation

Aquafil

- Phoenix Plant has begun Operations. Phase I Operational
- Beginning Phase II.
- California Plant in Initial Phase of Implementation.
- Process Converts **Nylon 6** PC Carpet into Virgin Like Nylon

Safe Path Products

- California Operation: Very Innovative Products
- **Sidewalk Repair Kits**: Thousands of kits needed needed
- **Instant Spill Absorber**: In final stages. Outperforms competitive products.
- **PC4** is main Carpet Ingredient
- **Cable Channels**: New Development: : PU + PC4

Visions Environmental

- California Operation: CARE Double Green Product.
- Colored aggregates Product: for Landscaping
- Using PC4 and Recycled paints as an ingredients
- Large opportunity in Asphalt Road Patches: Testing.
- 2 new product Groups
  - Road Bed Fill
  - Flowable Fill

Circular Polymers

- California Operation
- Expanding Rapidly: Additional Technology to reduce contaminants
- Developing large **PET** End Uses
- Processing Both **Nylon 6** and **Nylon 66**
- Supplier of Processed **PC4** to various companies for new products

Arropol

- CARE Grant Recipient
- Georgia Operation: Division of Star Chemicals
- Conversion of P.C. PET Carpet into Polyols
- Final Product: Polyurethane foams (Rigid & Flexible).
- In Startup mode and expansion
- Input product must be very clean: 97% range.

SwissTrax

- California Operation.
- Rubber Flooring manufacturer: Events Flooring
- Incorporating Granulated **PET/PP** in Swisstrax Ramp Edges.
- Testing via Grant is under way.
- Developing **PC4** into Tierra Verde Products
- Rubber Technology licensed to manufacturers

Swisstrax Ramp Edges Rubber Flooring

TierraVerde Family of Products

Interface

- Starting **Tile Recycling** Operation on West Coast
- Reclaimed PCV Backing will be used in new Tile products
- Will Reclaim Face fiber as well.

Miura Board

- **Houston Texas Operation**
- **Producing several Product Categories**
  - **Boards for Variety of Applications**
  - **Testing in progress - Prosthetics**
  - **Testing in progress - Flooring in Trailers**
- **One important component is PET Carpet fiber.**
  - PET does not melt in process: Gives boards Strength
- **High PC4 Content not critical**

SaN Pallets

- Past CARE Grant recipient
- Pallets Parts from Carpet PET and PP components
- Equipment Arriving for production.

Brotex

- Shearing **Nylon 6** Carpet Face fibers
- Output sold to Engineered Plastics
- Output is Pelletized on internal Extruder.
- One of the last remaining shearing operations in U.S.

PET Chemical Recycling: A new Life

Brand Owners are taking more and more interest in Recycling plastics amid the publicity of Ocean plastics, etc.

- Loop Industries: Proprietary Low Temp system.
  - Major Contracts with PET Brand Owners. Evian, Indorama, etc.
- Arropol: Internally Designed System:
  - PET >>>Polyols >>> Polyurethanes
- Eastman Chemicals: New Chemical Recycling initiatives
  - Methanolysis & Other systems under consideration

Thank You

- Questions