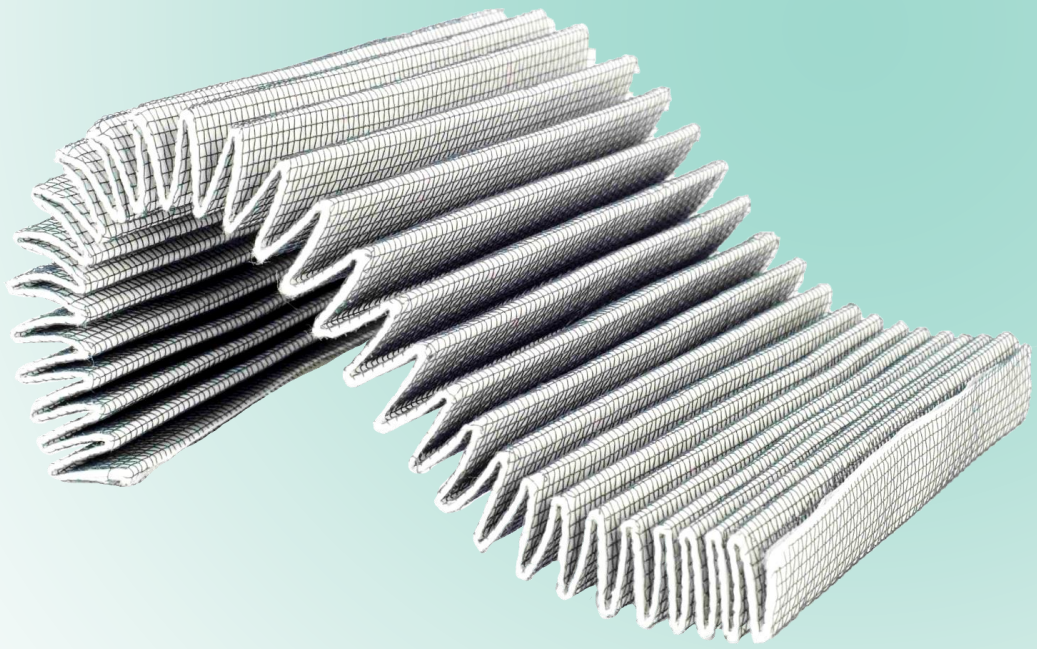
Benefits of Spunbond Substrate Uniformity in Advanced Filtration Media



Cerex Advanced Fabrics, Inc.

Introduction

Market demands for finer particle capture, increased dirt holding capacity and longer service lives in today's smaller, high pressure filtration systems are driving advancements in filter media designs.

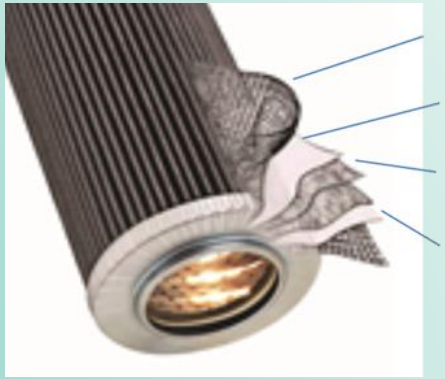
Advanced media designs often use multiple layer combinations of cellulose, micro-glass, synthetic fibers and/or membranes to achieve these increased performance requirements.

Many of these more advanced medias are relatively fragile and require structural support to prevent potential damage during processing and while in use.

Spunbond nonwoven fabrics can provide the needed structural support and may actually increase the performance of the filter media during real-life dynamic flow conditions.

Spunbond Use in Advanced Filter Media

Typically, the spunbond fabrics are placed on one or both sides of the filter media to provide downstream and upstream support.



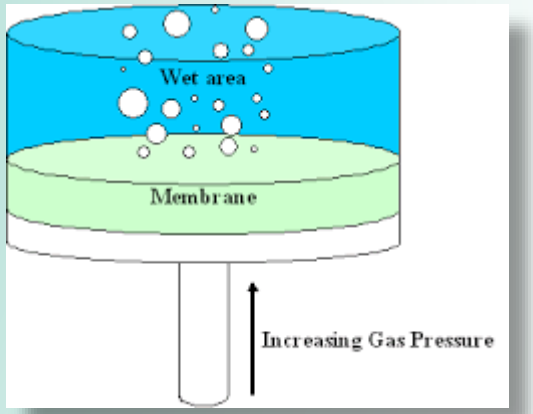
Some filter medias like synthetic melt blown, nano-fiber and cast membranes are produced directly onto the spunbond fabric and can be classified as "formational."

Other types of media, like wet laid cellulose and micro glass are produced separately from the spunbond and then co-pleated or bonded to the spunbond in a separate process. These can be classified as "laminated."

Impact of Uniformity

The industry recognizes that the uniformity of the *filter media* does matter and directly impacts the performance of the filter.

- **A variety of static test methods are used to quantify and verify the media consistency and performance, including among others:**
  - **The Bubble Point test (ASTM 316, ARP-901A),**
  - **The Multi-pass test (ISO 16889),**
  - **TSI 8130 (fka the DOP test), and**
  - **The Diesel/Petrol Filter Test (ISO 19438)**



But this raises a question……

Does the uniformity of the spunbond substrate used in the filter media also matter?

Does Spunbond Uniformity Matter?

With *formational* medias, the answer is unquestionably yes.

- Meltblown and nano-fiber formation are dependent on the substrate fiber "web" uniformity.
- Cast membrane performance is known to be dependent on the consistency of the substrate thickness.

With *lamination* medias, the answer is more difficult to quantify, especially using traditional "static" filter test methods.

- The spunbond substrate is to open a structure to act as a filter media, and traditional filter tests do not typically detect a benefit from the spunbond.

But what happens during actual use conditions when pressures, flow rates and contaminant levels are fluctuating versus static?

How to Quantify Spunbond Uniformity

Before we can evaluate the potential performance benefits of a more uniform spunbond substrate, we first must agree on methods to quantify uniformity.

- **Visual comparisons have been traditionally used, but are not quantifiable or reproducable.**

- **One option is to measure the consistency of substrate physical properties**

Basis Weight

Thickness

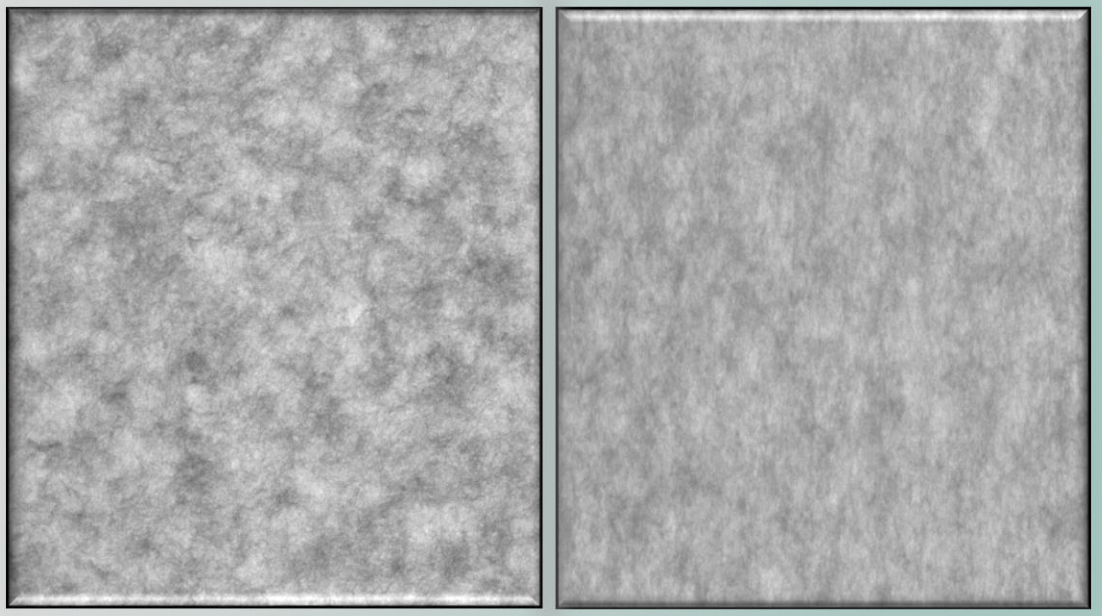
Air Permeability

- **Another option is to utilize digital camera technology and measure the consistency of light transmission through the spunbond.**

Visual Comparisons are Subjective

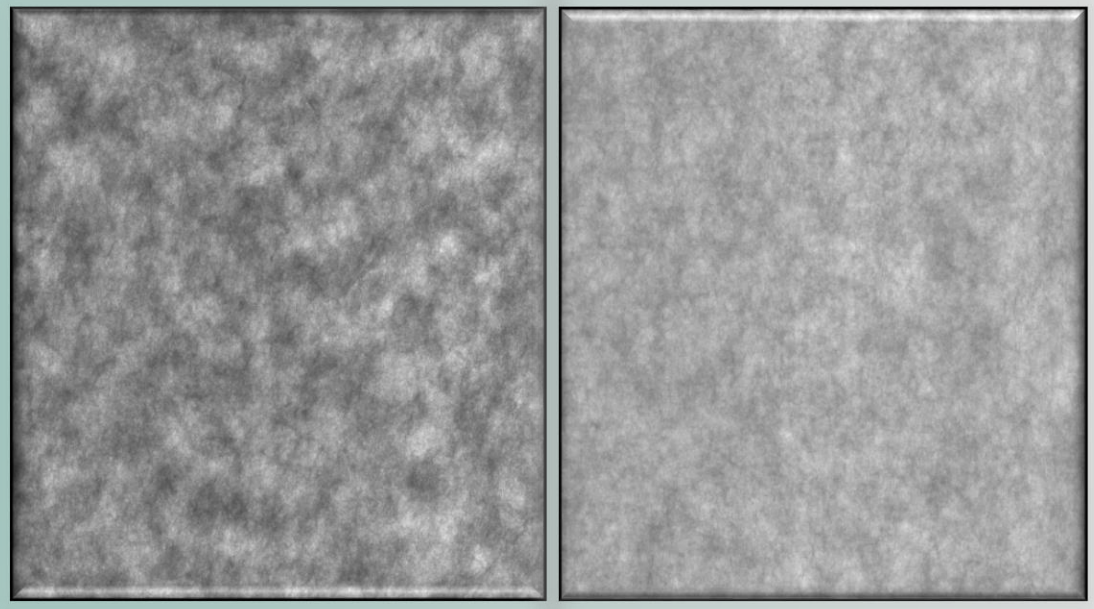
Sample size is 17 cm by 15 cm

20 GSM



Polyester Nylon 6,6

34 GSM



Polyester Nylon 6,6

Most people agree that the visual uniformity of Cerex® brand spunbond nylon is better than polyester

Unfortunately, visual assessments don't provide quantitative data for comparison

Physical Property Comparisons
Sampling Methodology

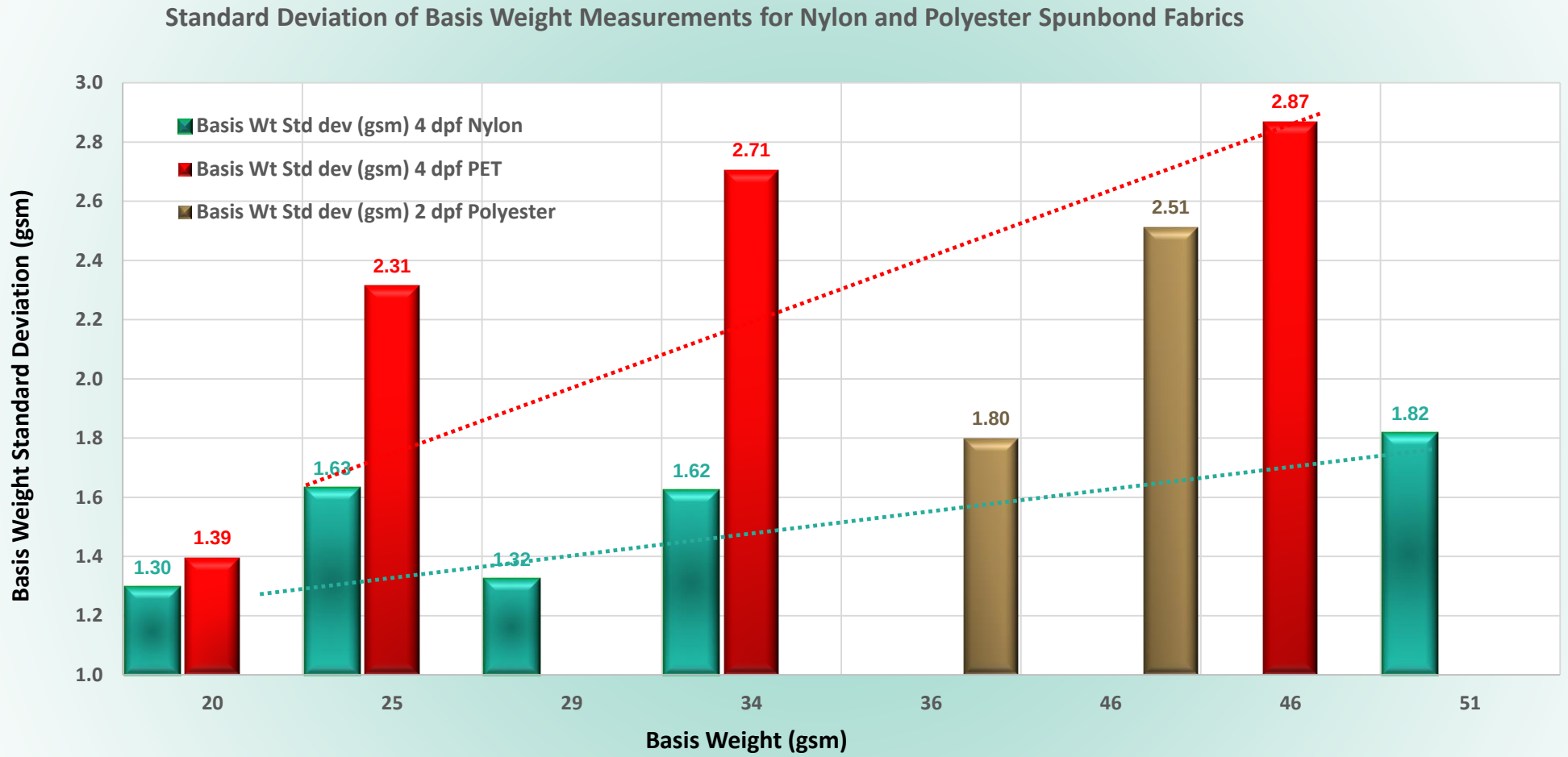
- Six (6) 64-72” wide commercially available PET spunbond rolls
- Five (5) 60” wide Cerex® spunbond nylon rolls
- Basis Weights ranged between 20 and 51 gsm
- 10 Full Width MD Samples taken every 10 meters
- 5 to 7 CD Samples taken every 30 cm across the spunbond width

A total of 50 to 70 samples tested per roll for statistical validity

And were tested using ASTM Standardized Methods

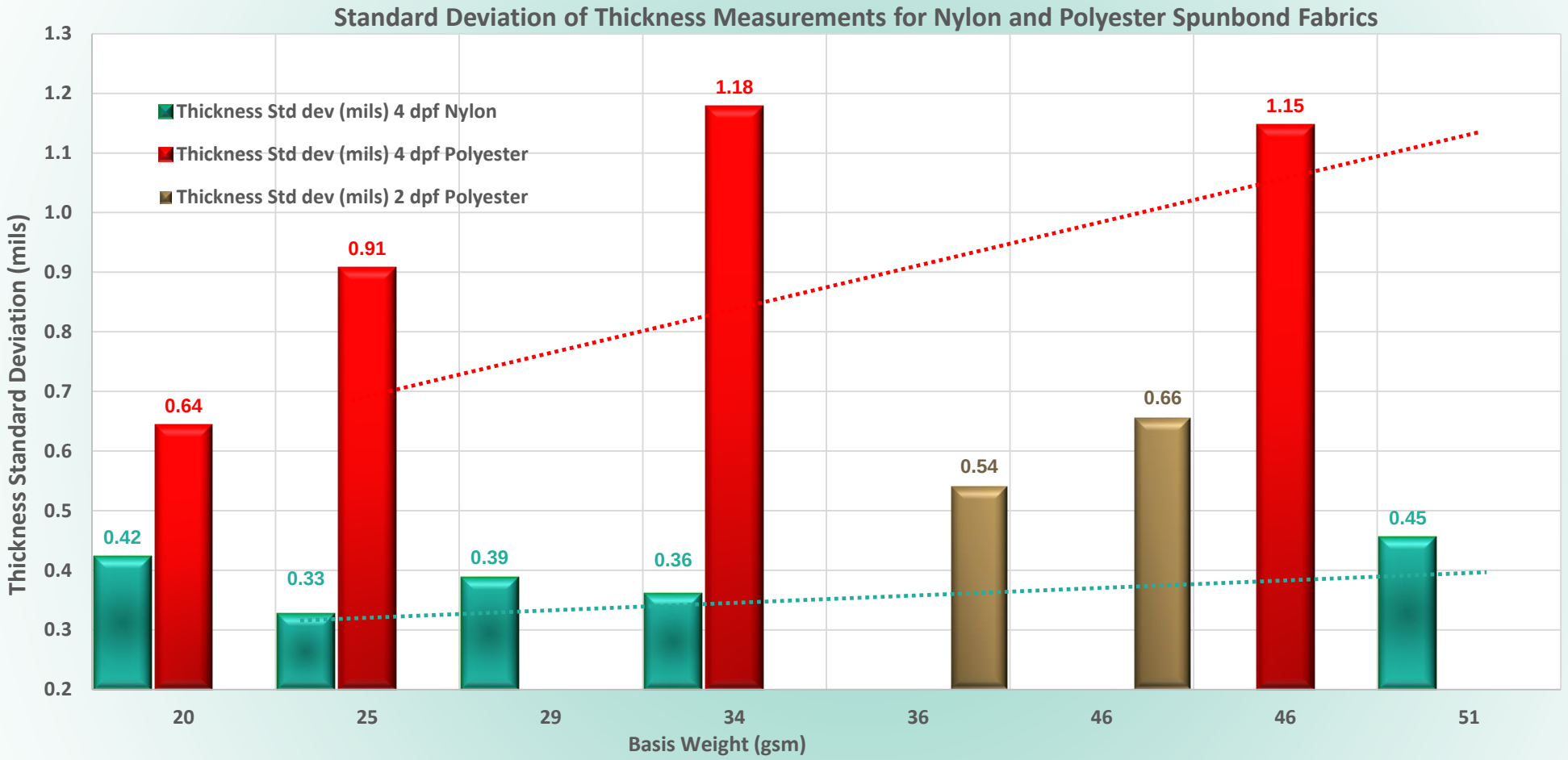
Basis Weight	Thickness	Air Perm
D3776	D1777	D737

Basis Weight Variability



More uniform basis weight leads to more uniform strength properties

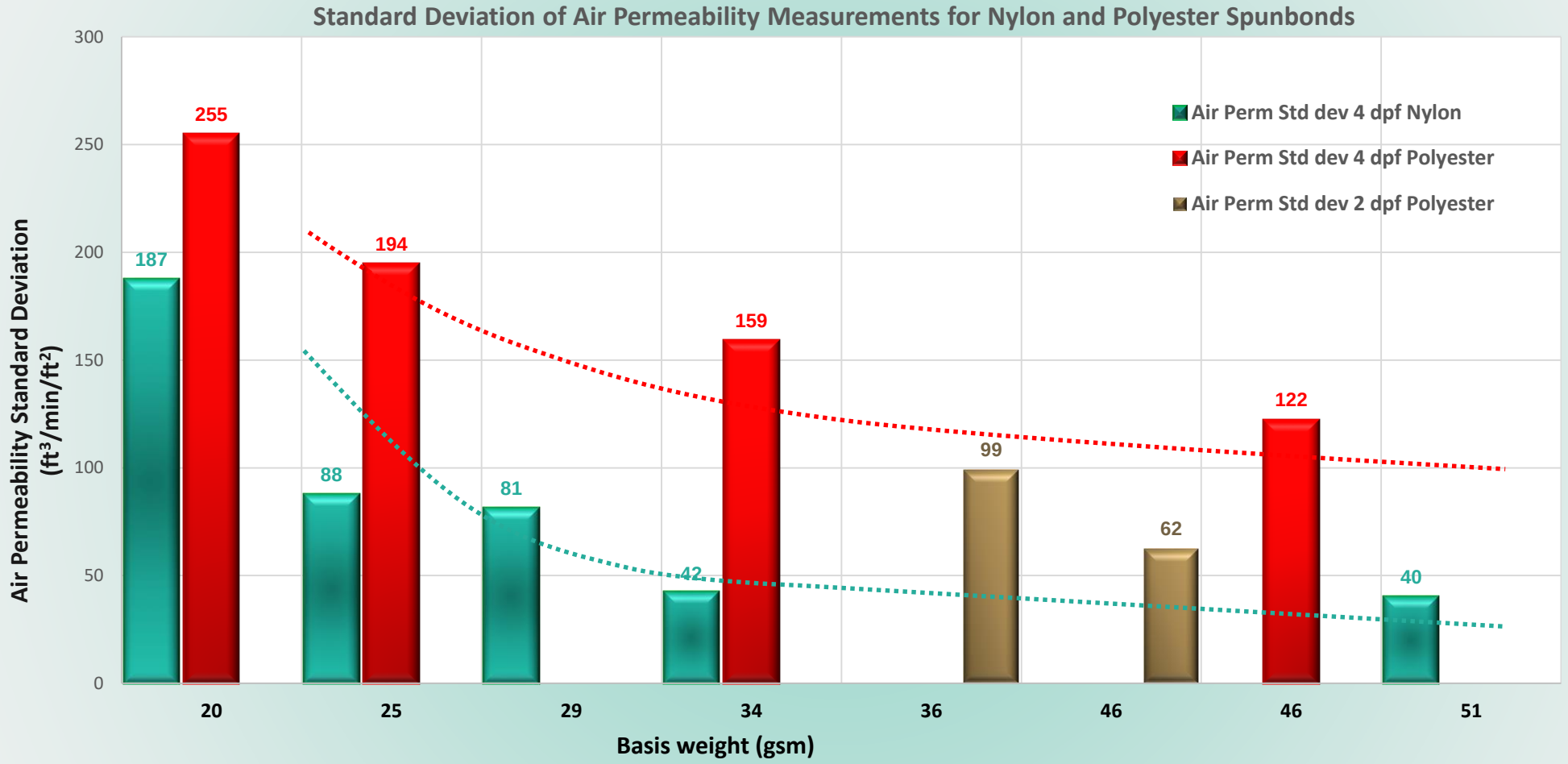
Thickness Variability



Thinner composite structures allow:

- ***More surface area (more pleats) or***
- ***Lower pressure drop (more space for fluid to flow)***

Air Permeability Variability



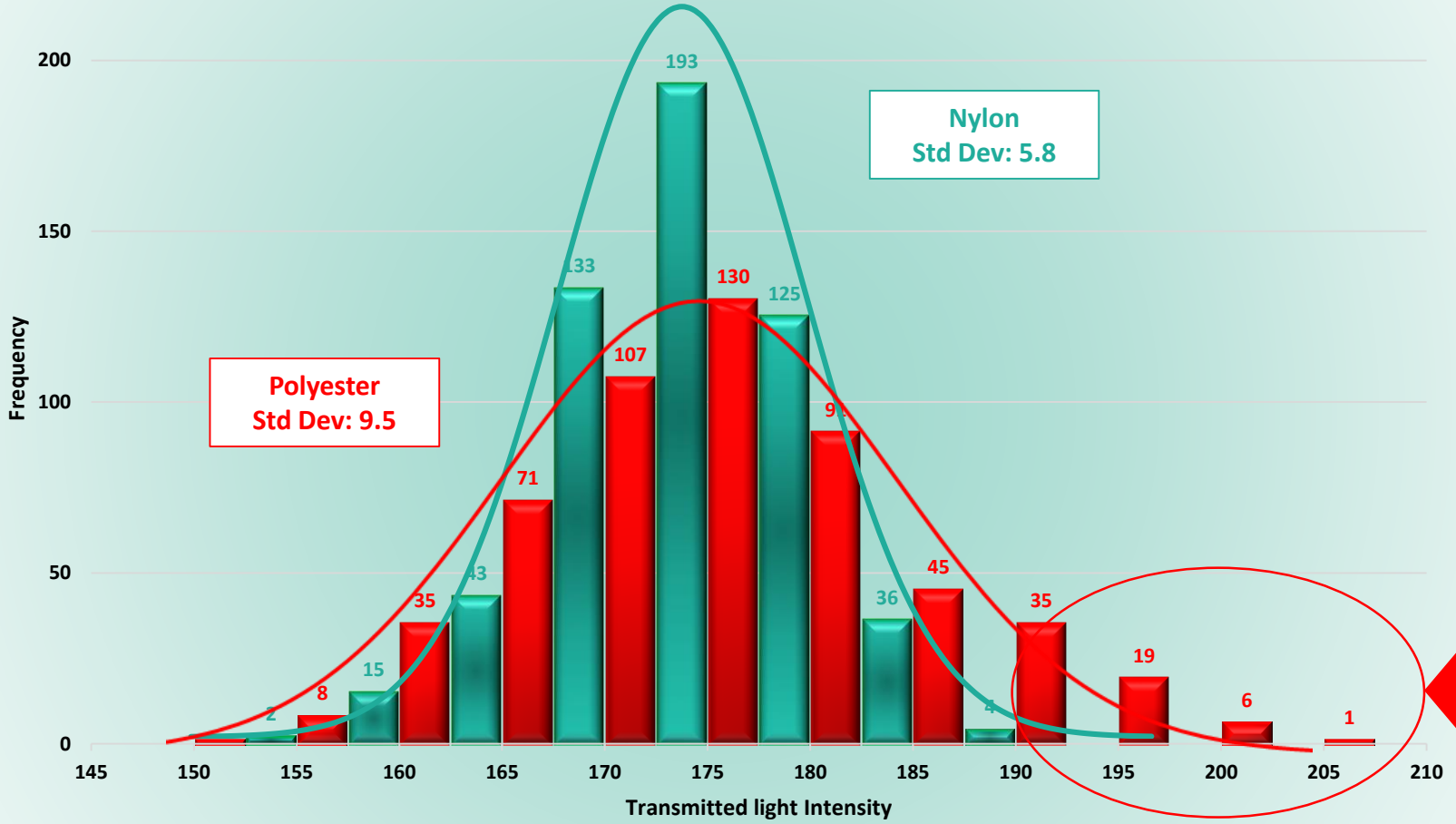
More consistent air permeability is a good indicator of a more consistent web formation

Comparing Uniformity using Digital Camera Technology

On-line camera system provides grey scale output of transmitted light which shows thick and thin spots on fabrics

Optical Representation of Fabrics

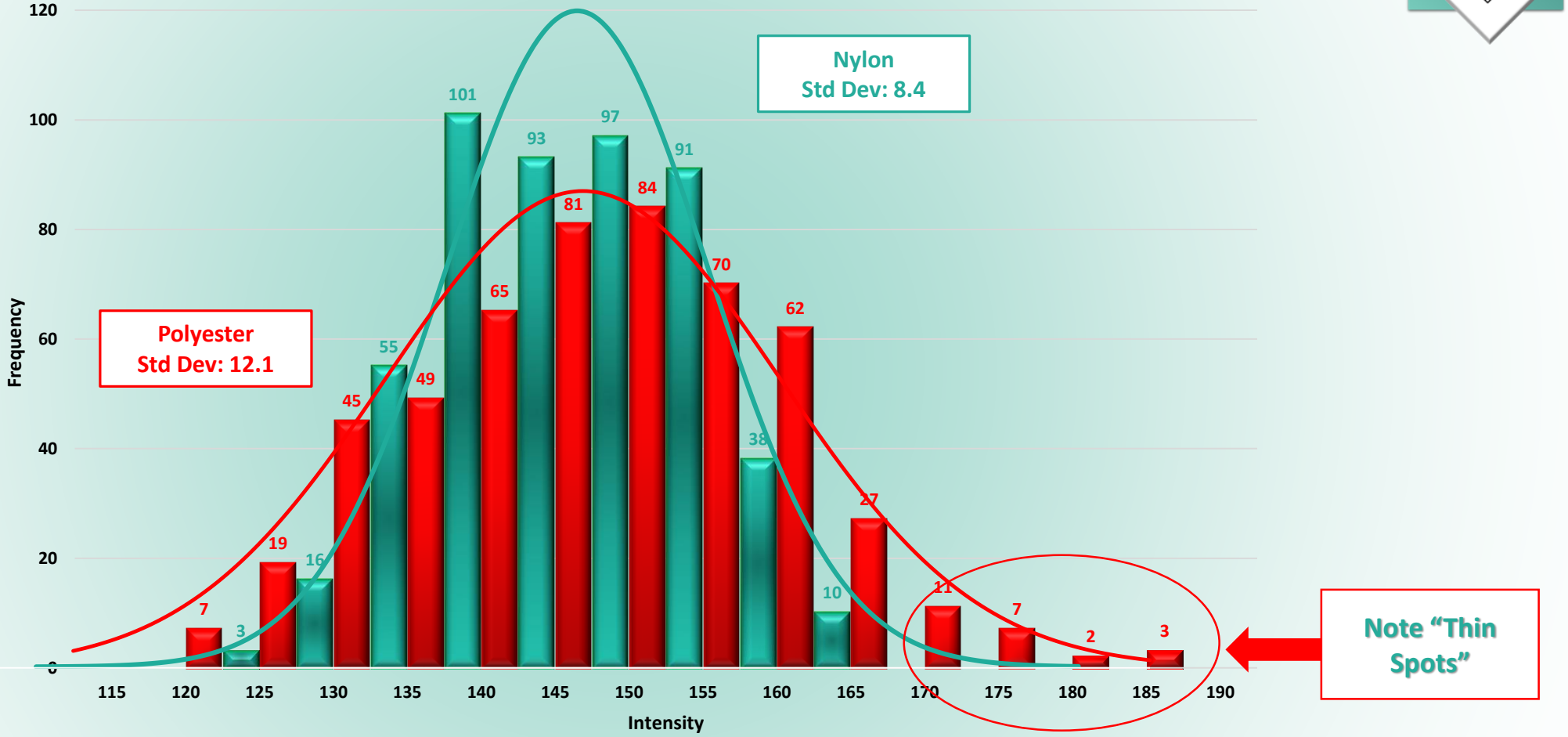
Histogram of transmitted light intensity for 20 gsm spunbond fabrics



These outliers are "thin spots"

Optical Representation of Fabrics

Histogram of transmitted light intensity for 34 gsm spunbond fabrics

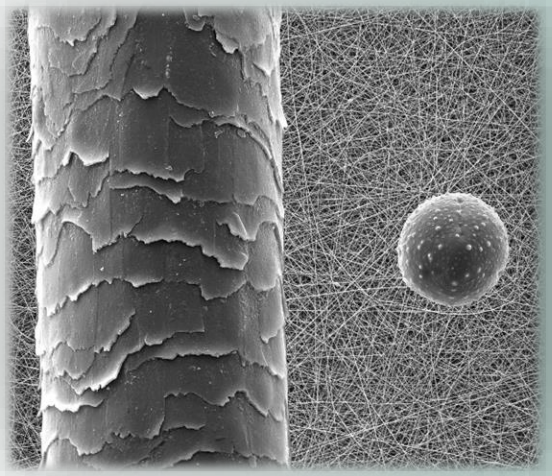


Transmitted light intensity data corroborates the physical property data

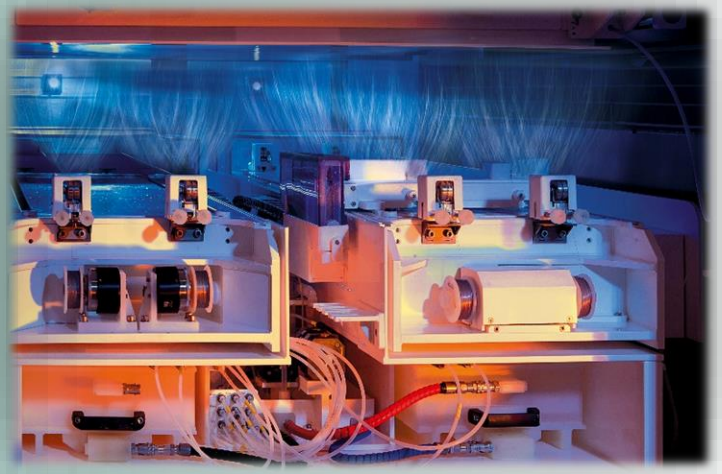
Case Study – Nanofiber Application

Same Process Conditions

TSI 8130 @32 lpm (0.3 µ particle)



% Penetration	34 gsm Cerex®	46 gsm Polyester
Average	8.4%	6.3%
Std Dev	1.2%	2.4%
Max % Pen (@ 3 Std Dev)	12.0%	13.5%

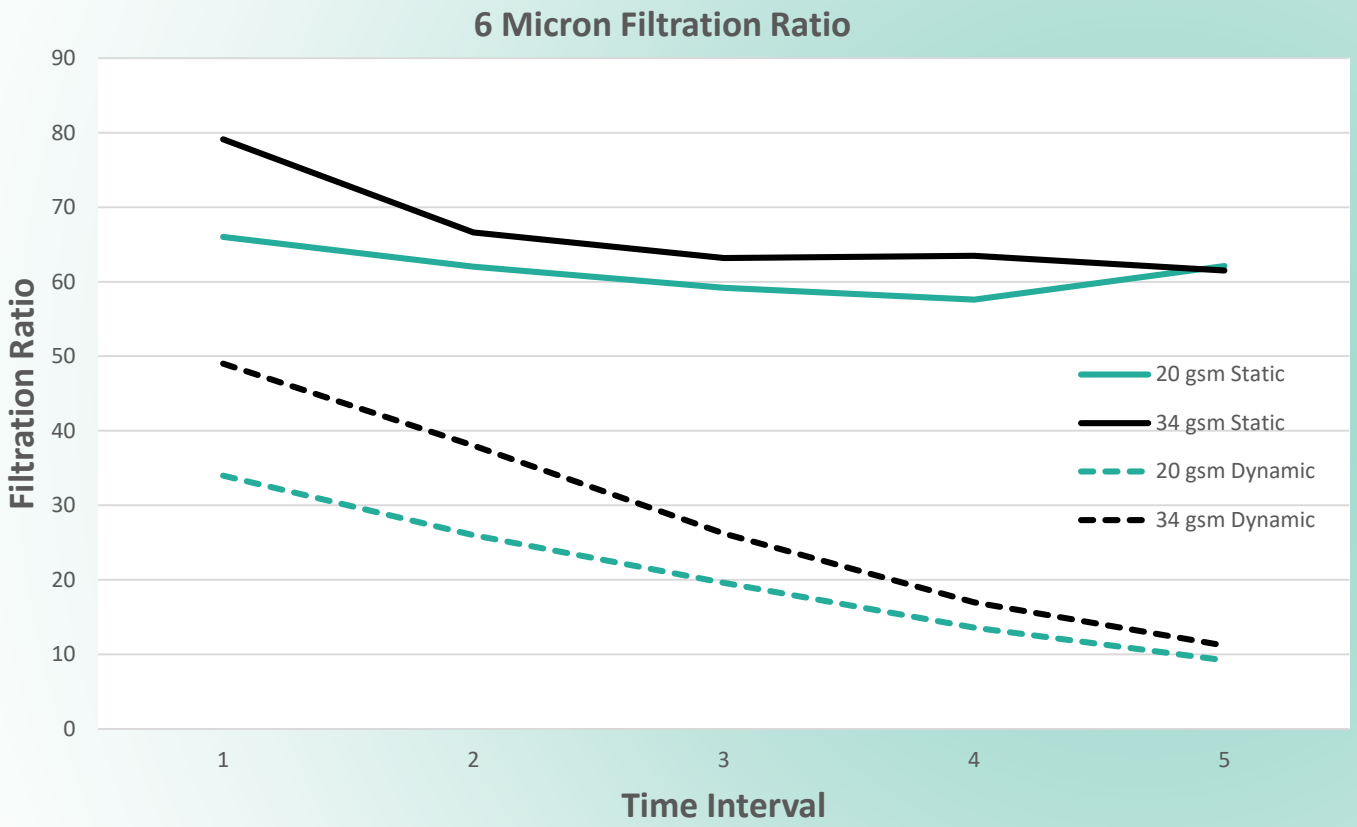


Nanofiber E –Spin on substrates at the same equipment settings (Line Speed, Voltage, etc)

- ***Cerex® basis weight was 25% less than the PET spunbond***
- ***TSI % Penetration variability range was twice as large for PET (14.4%) as the Cerex® (7.2%)***

Case Study - Hydraulic Dynamic Flow Testing

Cerex® Nylon Spunbond @ 20 gsm & 34 gsm



- ISO 16889 (Static) vs ISO 23369 (Dynamic)
- Flat Sheet Composite Testing
  - Epoxy coated wire both sides
  - Cerex substrate both sides
  - 6 micron microglass media
- Test Conditions
  - 200 sqcm test area
    - 6 lpm - Static
    - 2.5 to 10 lpm – Dynamic
  - Mil Std 5606 Oil with ISO Medium Test Dust
  - 125 Psid Terminal Pressure

Clean Delta P	Static	Dynamic
20 gsm	1.1 psi	1.7 psi
34 gsm	1.2 psi	1.8 psi

Flat Sheet testing showed some positive directional data, but failed prior to test completion.

Next Step is to test filter cartridges to eliminate “blow by” failures.

Conclusions

The CEREX® spunbond nylon had measurably greater uniformity than commercially available spunbond polyester.

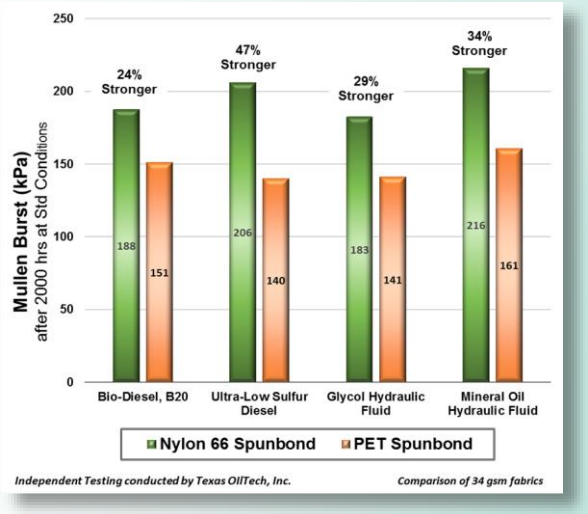
- ✓ Visually the CEREX spunbond appears more uniform
- ✓ Key physical properties were approximately twice as consistent
- ✓ Digital Camera analysis showed spunbond nylon was 30 – 50% less variable

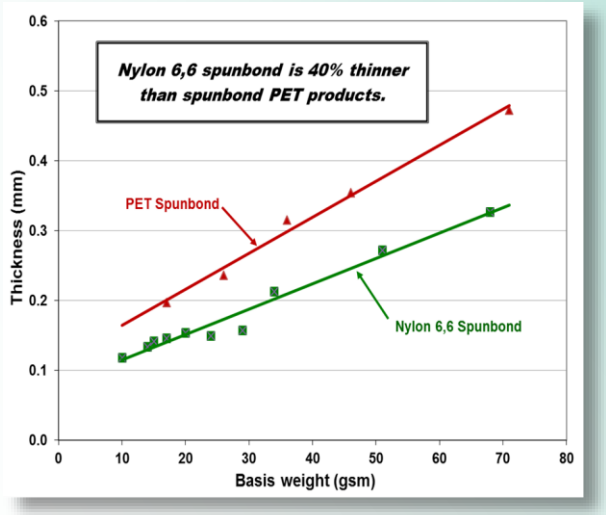
Electrospun nanofiber media performance showed lower penetration variability even at a 25% lower spunbond basis weight.

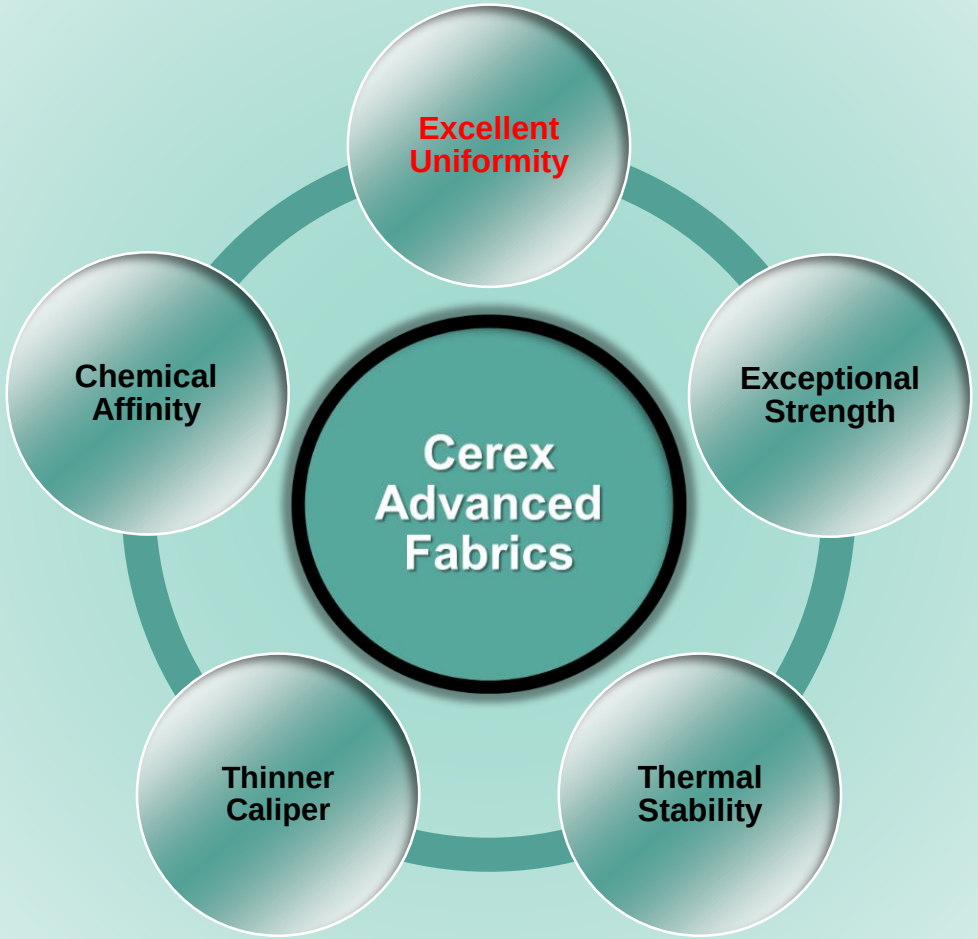
Dynamic flow testing on flat sheet lamination type media showed favorable directional information, but failed prior to test completion

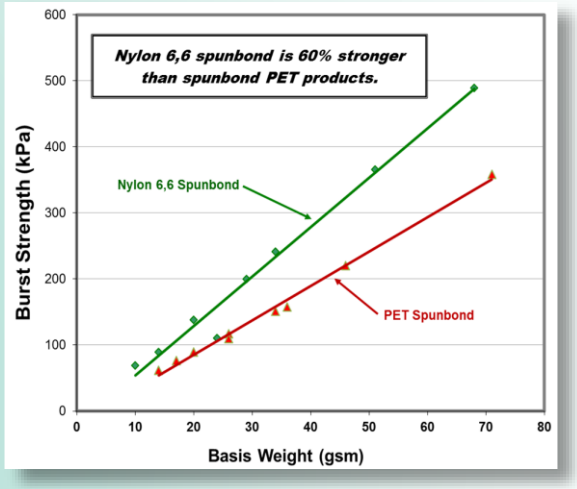
- ➢ Additional testing using filter canisters is being conducted to determine if spunbond uniformity impacts “in-use” dynamic flow conditions.

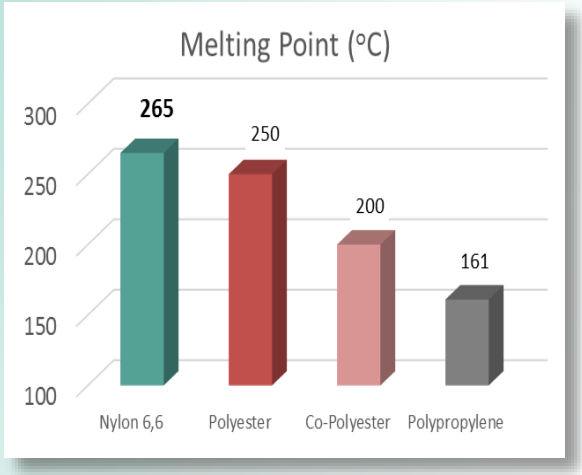
The Nylon Advantage® Matters!











Thank You

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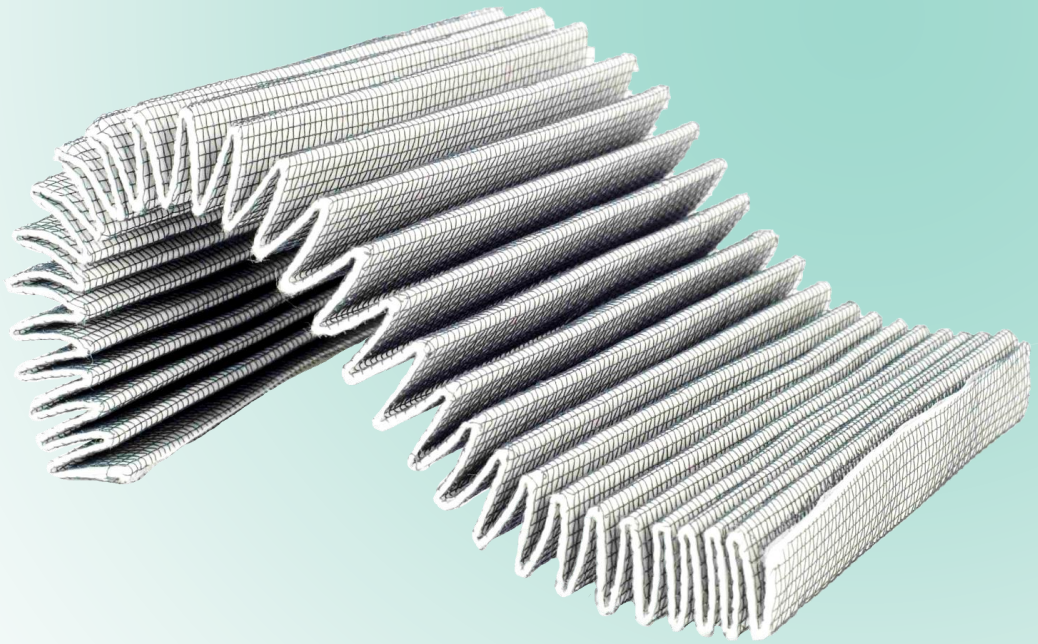

The Nylon Advantage®

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