PFAS ALTERNATIVES:

2024 AND BEYOND

AVIENT

TODAY'S SPEAKER

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He manages the Application Development and Technical Team and is focused on developing and delivering innovative solutions to customers.

Sean earned a Bachelor of Science degree in Biochemistry from Virginia Tech in Blacksburg, VA, and a Master of Business Administration from Pamplin College of Business.

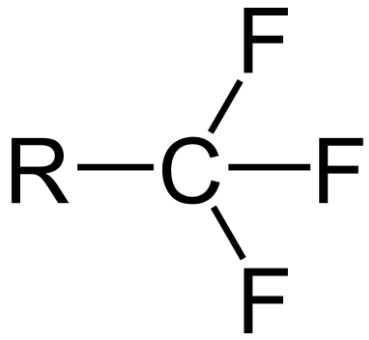
AGENDA

- What are PFAS* and Why are we here?
- Why are PFAS used? (Performance and Properties)
- Avient areas of focus / future development
  - Non-PFAS Low Retention
  - Non-PFAS PPA
  - Non-PFAS water/alcohol repellency

* Per- and polyfluoroalkyl substances

WHAT IS PFAS

- Per-and polyfluoroalkyl substances (PFAS) are defined as fluorinated substances that contain at least one fully fluorinated methyl or methylene carbon atom (without any H/Cl/Br/I atom attached to it)
- Potential health and safety concerns due to PBT (persistent, bioaccumulative, and toxic) characteristics of some PFAS
- Many PFAS, including perfluorooctane sulfonic acid (PFOS) and perfluorooctanoic acid (PFOA) have concerns regarding environmental impact
  - Environmental persistence
  - Trace amounts in soils & drinking water
  - Build up (bio-accumulate**)** in fish and wildlife



PFAS UTILIZATION: WHY AND HOW THEY ARE USED

INDUSTRIES

- Packaging
- Healthcare
- Consumer goods
- Industrial materials

TYPICAL FUNCTIONS

- Chemical inertness
- Thermal stability
- Water repellents (hydrophobicity)
- Oil repellents (lipophobicity)
- Low surface energy
- Low coefficient of friction (CoF)

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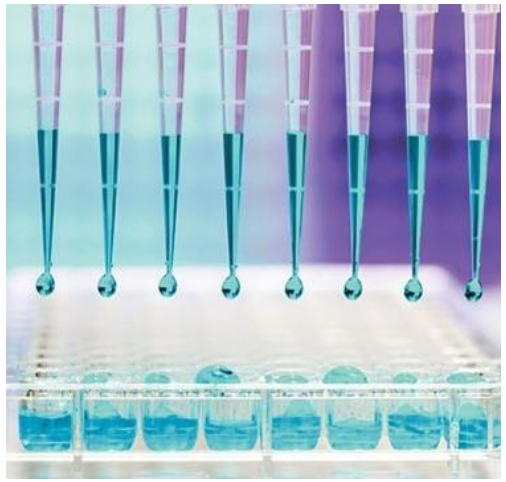
IMPACTED FUNCTIONALITY

AREAS OF NON-PFAS ADDITIVE DEVELOPMENT

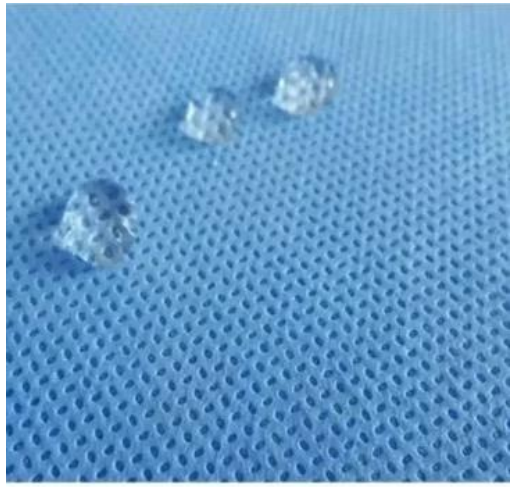


HYDROPHOBICITY FUNCTION

- LOW SURFACE ENERGY
- CLARITY
- DIMENSIONAL STABILITY
- RADIATION STABLE

POLYMER PROCESSING AID

- MELT FRACTURE REDUCTION
- DIE BUILD-UP REDUCTION
- HIGH EFFICIENCY
- FDA COMPLIANCE



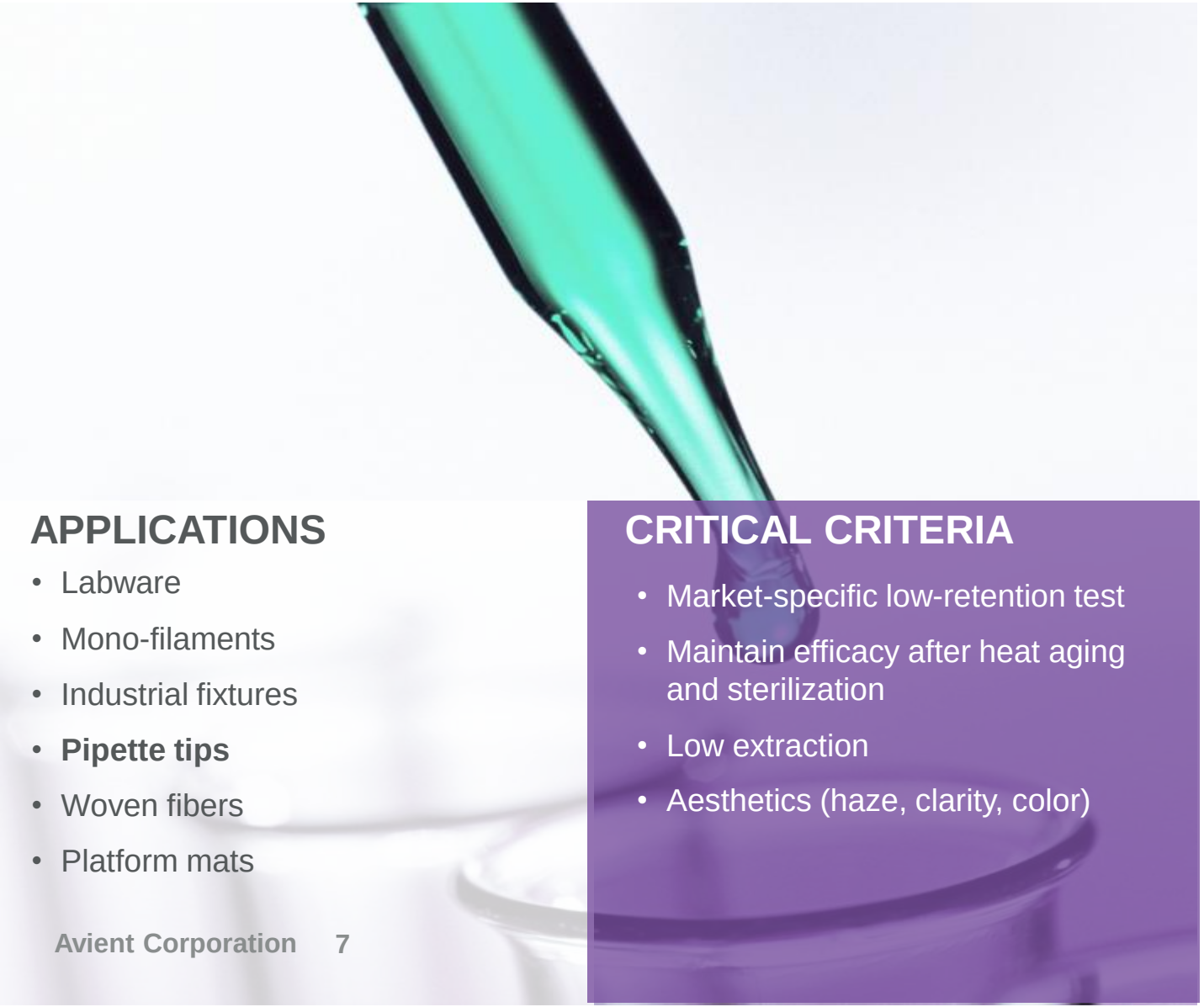
FIBER WATER/ALCOHOL REPELLENCY

- LOW SURFACE ENERGY
- GOOD PROCESSABILITY
- THERMALLY STABLE
- LOWER CONCENTRATIONS

LOW COEFFICIENT OF FRICTION PTFE REPLACEMENT

- INTERNALLY LUBRICATED
- SIMILAR COF TO PTFE
- MANAGEABLE DROP IN MECHANICAL PROPERTIES

LOW RETENTION ADDITIVES (HYDROPHOBIC)



APPLICATIONS

- Labware
- Mono-filaments
- Industrial fixtures
- **Pipette tips**
- Woven fibers
- Platform mats

CRITICAL CRITERIA

- Market-specific low-retention test
- Maintain efficacy after heat aging and sterilization
- Low extraction
- Aesthetics (haze, clarity, color)

MARKET NEED

Primary fluorinated solution was discontinued. Develop a fluorine free solution that met all of the regulatory, aesthetic and efficacy requirements across product variables.

KEY BENEFITS

- Maintain efficacy after sterilization.
- Equivalent low retention properties to fluorinated solutions.
- Eliminate secondary coating or wetting process

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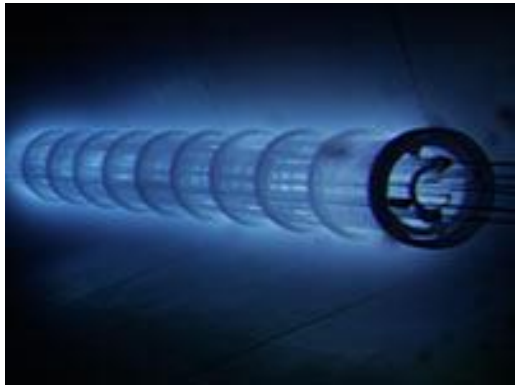
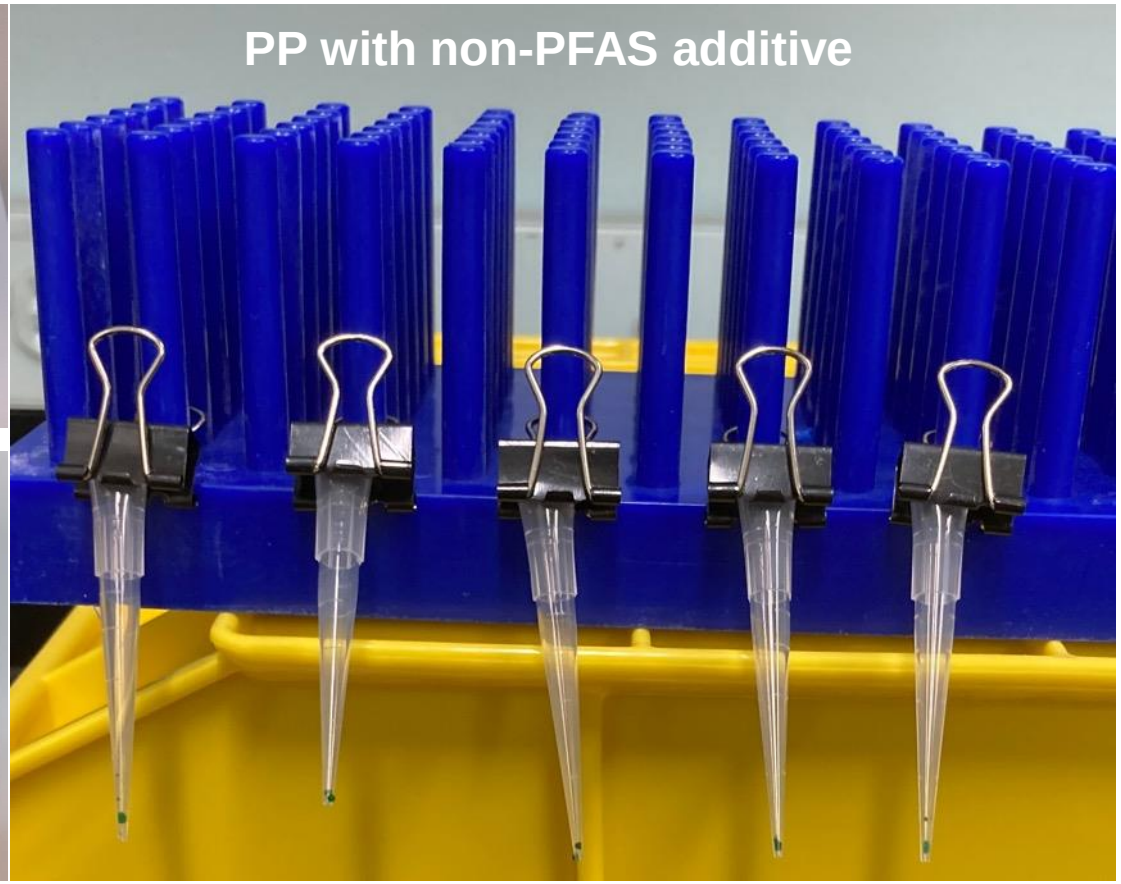
PROCESS FLOW FOR AVIENT'S LOW RETENTION NON-PFAS SOLUTIONS

Sterilization (gamma or e-beam or autoclave)



LOW RETENTION PERFORMANCE OF AVIENT'S NON-PFAS SOLUTIONS



Green Dye Test

POLYMER PROCESS AID

TRADITIONAL FLUORINATED PPA MECHANISM

Incompatible with polymer and sticks to the metal surface, thin coating formed in the extruder die

Reduces the friction between the molten polymer and the metal

Allows the polymers to be extruded more easily

APPLICATIONS

- Blown film
- Extruded sheet
- Extrusion blow molding
- Profile extrusion
- Pipe extrusion

MARKET NEED

Develop a fluorine-free solution to reduce the friction between the molten polymer and metal; enabling the polymers to be extruded more easily

- Reduce melt-fracture
- Reduce die build-up
- Improve process efficiency

KEY BENEFITS

- Retention of sealability and printing
- Both solid and liquid alternatives
- Very low loadings –
  - Conventional solution = 1-5% LDR
  - Non-PFAS concentrate = 0.5-2% LDR

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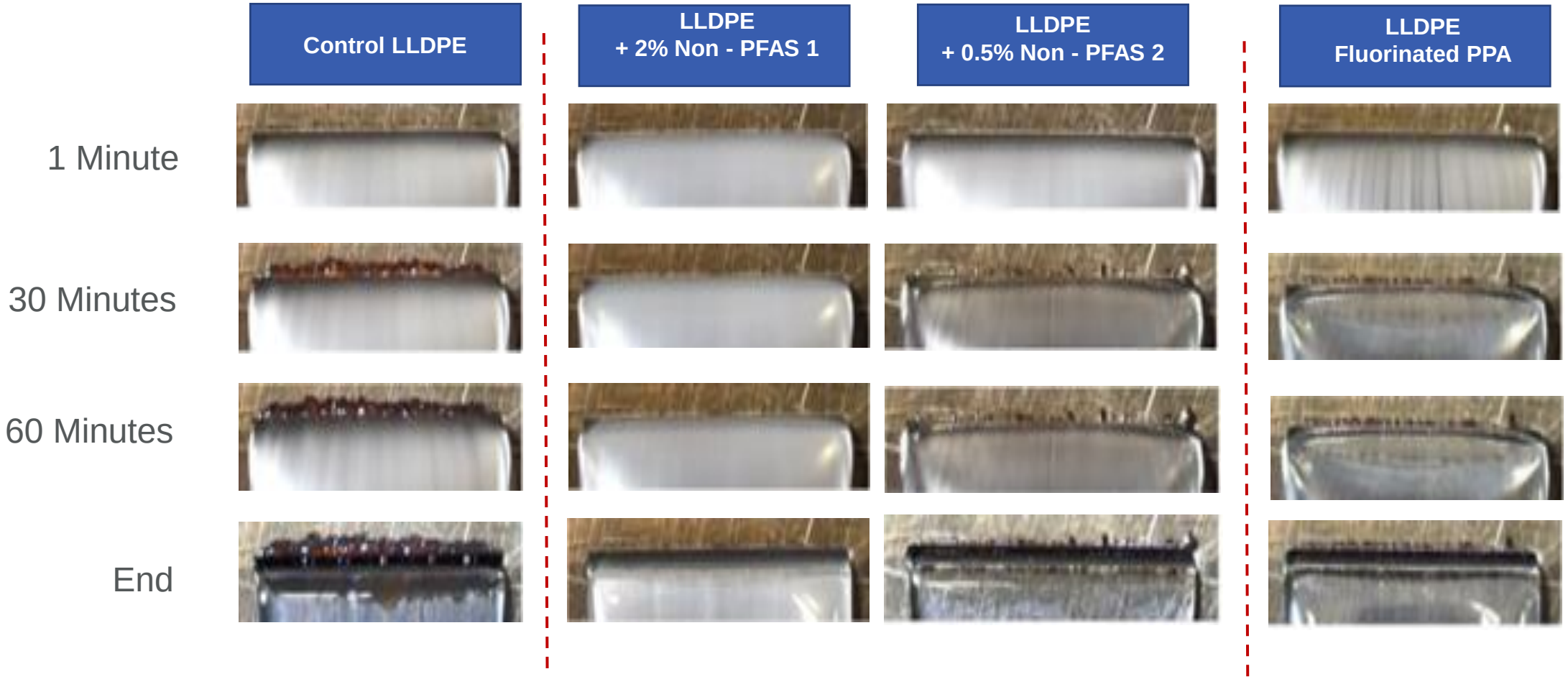
DIE-BUILD UP TESTING

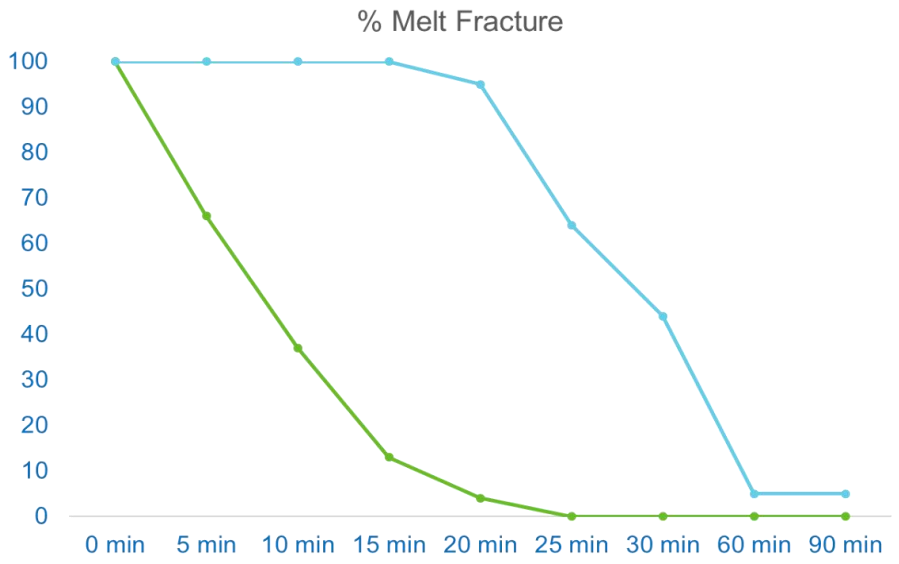
INTERNAL TEST METHOD WITH HIGH SHEAR RATES



PROCESS EFFICIENCY IMPROVEMENT

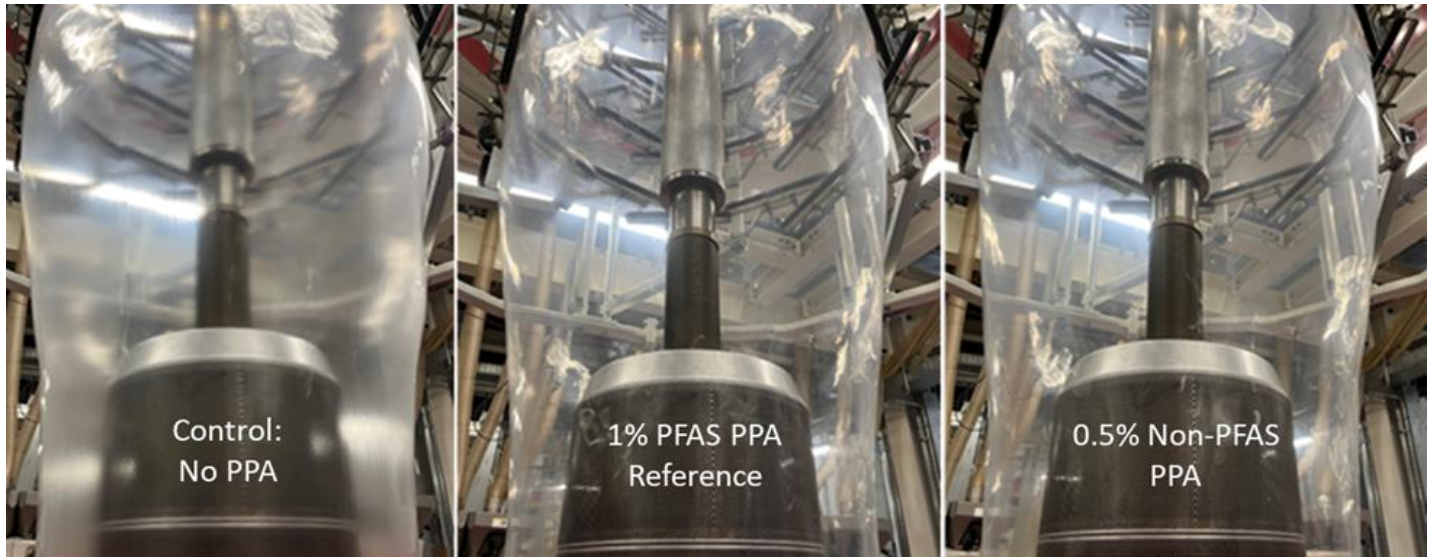
MELT FRACTURE TEST RESULTS

Internal Avient testing methods



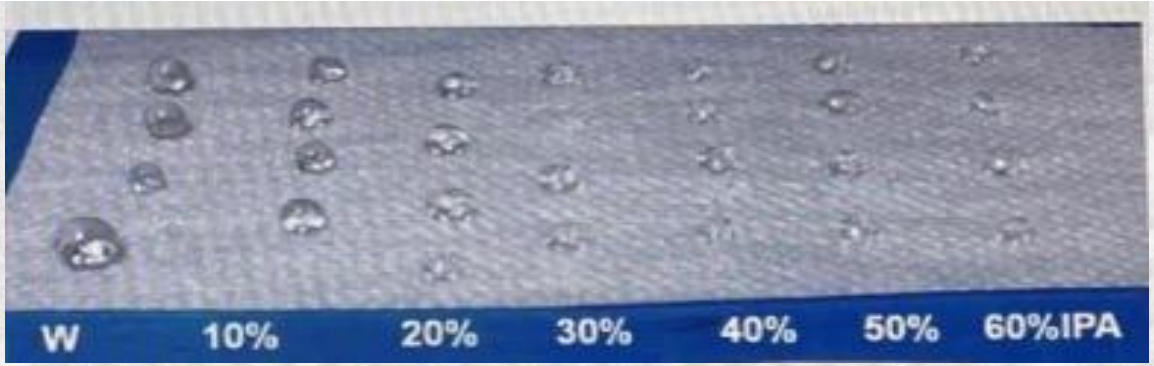
Non-PFAS Liquid PPA **Standard F-based PPA**

Production Scale Results

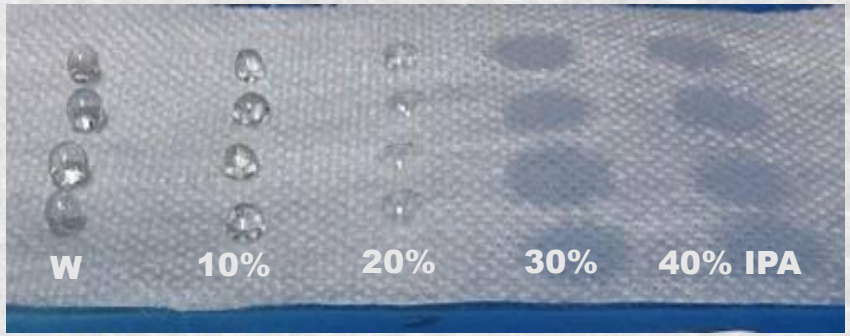


- Provide better process stability
- Improve productivity
- Reduce die pressure
- Reduce power requirement

WATER & ALCOHOL REPELLENCY IN NON-WOVEN PP



PFAS standard



Non-PFAS version

AATCC TM-193

APPLICATIONS

- Diapers
- Health care
- Building and Construction
- Personal care
- Geo textile

CRITICAL CRITERIA

- Water **and** Alcohol Repellency
  - Targeting Grade 4 performance
- Process stability

MARKET NEED

Develop a fluorine free solution that meets regulatory, provides excellent hydrophobicity and is thermally stable.

KEY BENEFITS

- Comprehensive benchmark studies compared to traditional PFAS materials
- Testing in various PP grades
- Both liquid and solid solutions
- Technical support

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LOW COEFFICIENT OF FRICTION PTFE REPLACEMENTS

APPLICATIONS

- Catheters
- Lubricated Bearings / Gears
- Furniture Hinges and Runners

MARKET NEED

Develop a fluorine-free solution that provides similar coefficient of friction and physical property characteristics to traditional PTFE blends

KEY BENEFITS

- Equal to or better CoF results
- Lower loading requirements in final
- Marginal drop in mechanical properties
- Technical support

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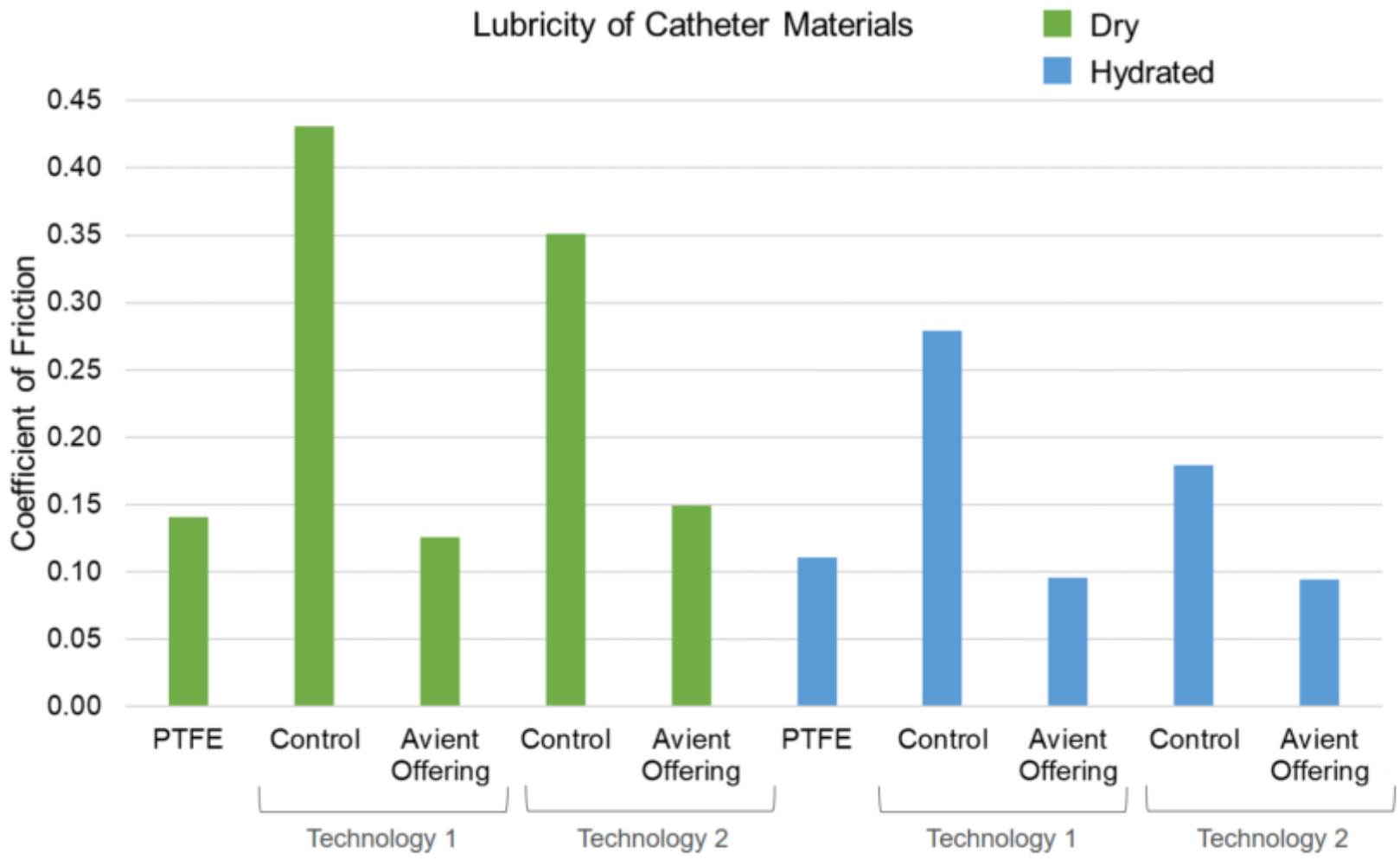
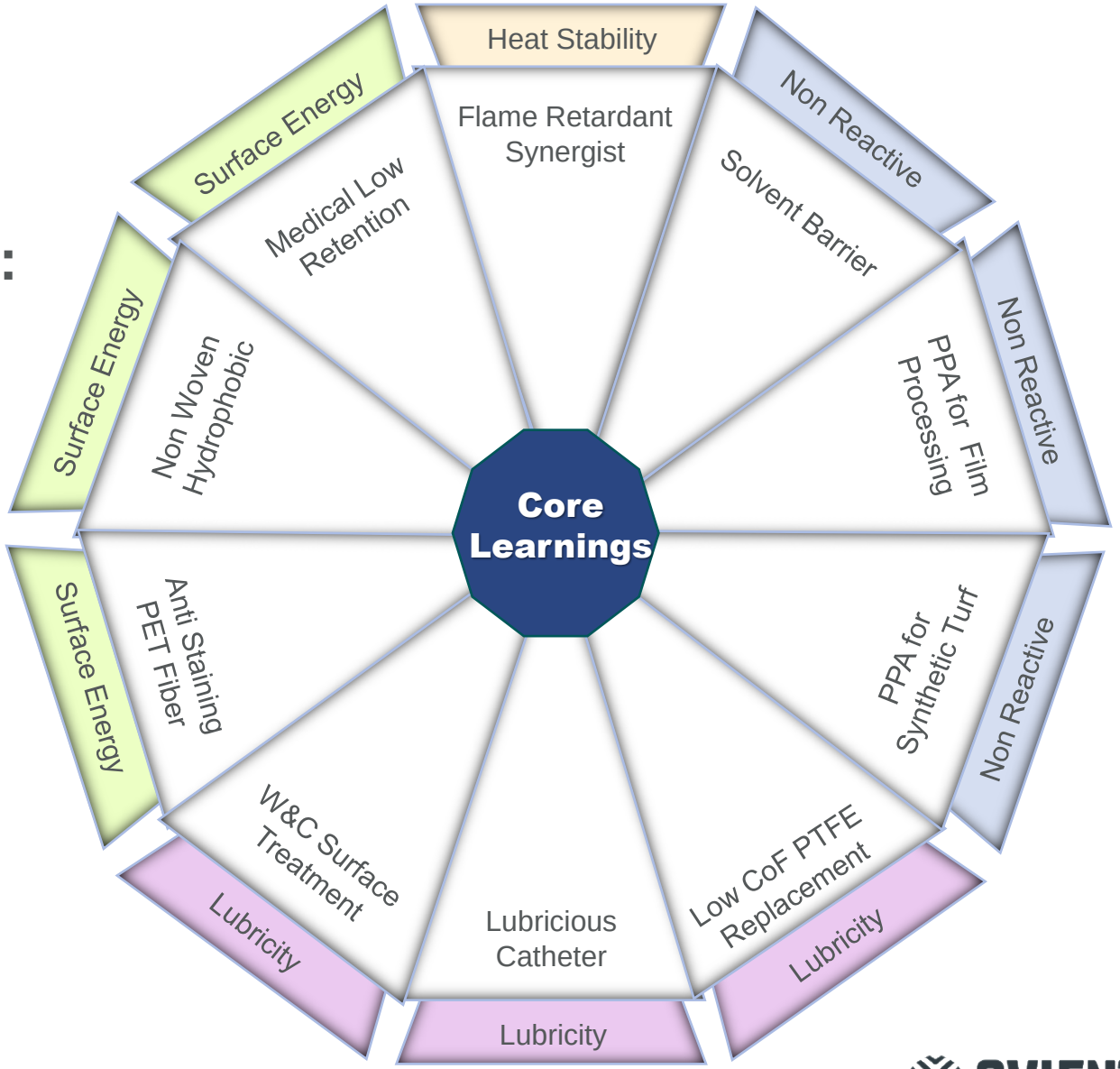
NON-PFAS ALTERNATIVE TO PTFE IN LUBRICIOUS CATHETER APPLICATION



ADDITIONAL AREAS OF FOCUS

Targeted Performance Characteristics:

- **Surface energy modification**
- **Die build-up/melt fracture reduction**
- **Moisture management**
- **Low Coefficient of Friction**
- Solvent Barrier enhancement
- Process enhancement
- Non PFAS Drip Suppressant



QUESTIONS?

THANK YOU FOR YOUR TIME