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THE PFAS-FREE FUTURE: ENGINEERING PERFORMANCE UNDER EVOLVING REGULATION

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INTRODUCTION: PERFORMANCE ALONE IS NO LONGER ENOUGH

For decades, PFAS-based chemistries, including fluoropolymers such as PTFE, have enabled reliable performance in polymer applications. Their low surface energy, chemical stability, and tribological durability made them well suited for molded plastic components such as gears and bearings, as well as fiber and nonwoven systems requiring fluid repellency and surface control.

Historically, material selection decisions were driven primarily by performance and manufacturability. If a compound delivered required friction characteristics, wear resistance, chemical durability, and process stability, it was considered fit for purpose.

Today, the equation has changed.

In early 2026, PFAS regulation continues to evolve across global markets. The result is a fragmented regulatory landscape. Requirements vary by region, application, and product category.

In the United States, state-level restrictions on PFAS are rapidly expanding, increasing compliance complexity for manufacturers. Federal reporting requirements under the Toxic Substances Control Act add documentation and traceability obligations. In the European Union, class-based restriction proposals under REACH are reshaping long-term material planning and investment strategies. In Asia and other regions, substance-specific controls and manufacturing emissions oversight are developing in parallel.

Beyond formal regulation, major OEMs and global brands have adopted independent PFAS-free commitments, further accelerating supply chain expectations.

However, the directional signal is consistent: materials must not only perform, they must remain defensible under evolving regulatory frameworks. PFAS replacement is therefore not a simple material substitution exercise. It requires rebuilding the functional performance once delivered by fluorinated chemistries through engineered material systems.

Americhem addresses this challenge through two complementary, flexible technology platforms:

- **EcoLube™**, a PFAS-free engineered compound platform for tribological performance in molded plastic parts
- **nDryve™**, a PFAS-free masterbatch platform designed to enhance surface-modifying performance in polyolefin and engineered fiber systems

Both platforms are designed to adapt across base resins, application demands, and changing regulatory conditions.

WHAT IS PFAS, AND WHY REPLACEMENT IS TECHNICALLY COMPLEX

PFAS refers to a broad family of fluorinated substances with differing chemical structures and physical behaviors. Non-polymeric PFAS are small, mobile molecules that have been the primary focus of environmental and health research due to persistence and potential exposure pathways. Polymeric PFAS, including fluoropolymers such as PTFE, are high molecular weight materials engineered to remain embedded within polymer matrices.

Despite functional differences, regulatory frameworks increasingly evaluate PFAS based on chemical classification rather than exposure profile alone. This creates uncertainty for manufacturers whose legacy formulations rely on fluoropolymers for performance.

From an engineering perspective, PTFE and related materials often provided multiple functions simultaneously:

- Low friction under sliding contact
- Stable wear performance under load
- Chemical and thermal resistance
- Surface energy reduction for fluid repellency

Because these attributes were bundled within a single fluorinated material, replacement requires coordinated design. No single additive replicates all functions. Instead, performance must be rebuilt through material architecture, combining lubrication, reinforcement, and surface energy control mechanisms.

Americhem's strategy is platform-based rather than product-specific. By leveraging both engineered compounds and masterbatch technologies, solutions can be tailored to a wide range of base resins and processing environments.



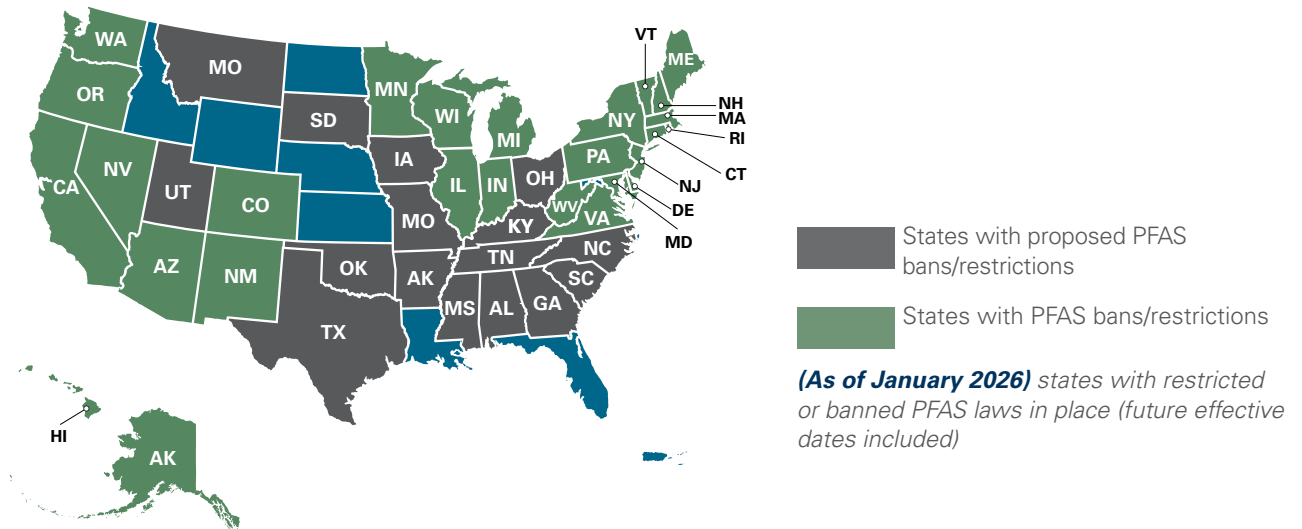
REGULATORY LANDSCAPE IN THE U.S. AND BEYOND

2026 SNAPSHOT

The current regulatory environment is characterized by fragmentation and acceleration:

For engineering and regulatory teams, the implication is clear: Materials must be selected not only for present compliance, but for regulatory durability across product lifecycles and global markets. Requalification cycles, reformulation risk, and documentation burden all factor into material decisions.

Flexible material platforms that anticipate regulatory evolution can reduce mid-program disruption and long-term supply chain instability.



Country	Regulations
United States	<ul style="list-style-type: none"> Expanding state-level bans on intentionally added PFAS in defined product categories Ongoing federal reporting requirements and substance tracking Increased focus on drinking water limits and environmental monitoring
European Union	<ul style="list-style-type: none"> Active evaluation of PFAS under REACH, including class-based restriction proposals Consideration of transition timelines and sector-specific exemptions
Asia-Pacific	<ul style="list-style-type: none"> Substance-specific controls and heightened scrutiny of manufacturing emissions Growing regulatory alignment with global sustainability initiatives
Global Brands and OEMs	<ul style="list-style-type: none"> Independent PFAS-free commitments Increased documentation and supplier transparency requirements

Molded Plastic Applications: EcoLube™ PFAS-Free Tribological Performance

In molded plastic systems such as gears, bearings, and actuation assemblies, PTFE historically addressed friction reduction, wear control, and dimensional stability under load. These properties were critical in applications where smooth motion, noise reduction, and durability were required over extended service life. EcoLube™ is Americhem's PFAS-free lubricated compound platform developed to replicate these functions through engineered material systems.

Rather than relying on fluorinated additives, EcoLube™ formulations integrate complementary mechanisms within the polymer matrix:

- Surface-interacting lubricant systems that reduce shear and start-up friction
- Embedded solid-state lubricants that support stable wear resistance
- Structural reinforcements such as glass or carbon fiber that improve load distribution and dimensional stability



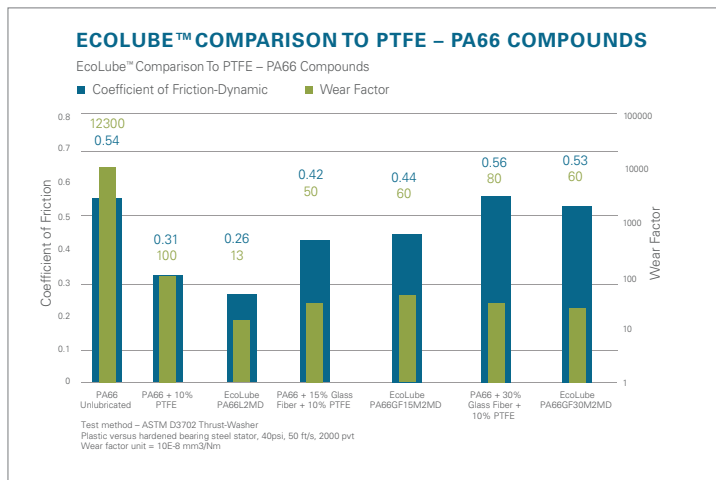
TRIBOLOGICAL PERFORMANCE VALIDATION

Tribological performance has been validated using ASTM D3702 thrust washer testing. Across multiple resin systems, including PA66, PC, and POM, EcoLube™ formulations demonstrate low coefficients of friction and wear factors comparable to PTFE-containing controls under defined load and speed conditions.

Mechanical performance remains equally important. EcoLube™ compounds maintain impact strength, tensile properties, and structural integrity while often reducing density relative to PTFE-filled grades. This supports lightweighting initiatives and metal replacement strategies without sacrificing reliability.

EcoLube™ is adaptable across a wide range of engineering resins, including high-temperature polymers such as PEEK and PPSU. This flexibility allows engineers to address varying performance challenges while aligning with regional regulatory constraints.

EcoLube™ Performance Data



EcoLube™ delivers consistent low-friction and wear performance across multiple engineering resins, including PA66, POM, and others, under defined load and speed conditions.

EcoLube™ Comparison to PTFE - PA66 Compounds

Test	Density	Notched Izod Impact Strength	Tensile Strength	Flexural Modulus
Method	ASTM D792	ASTM D792256	ASTM D638	ASTM D790
Units	g/cm ³	ft-lbs./in.	psi	psi
PA66 + 10% PTFE	1.20	1.00	10,400	434,000
EcoLube™ PA66L2MD	1.11	1.50	9,900	416,000
PA66 + 15% GF + 10% PTFE	1.31	1.25	15,300	850,000
EcoLube™ PA66GF15M2MD	1.22	1.45	14,200	748,000
PA66 + 30% GF + 10% PTFE	1.45	2.90	20,500	1,305,000
EcoLube™ PA66GF30M2MD	1.34	3.90	20,400	1,270,000



PFAS-free EcoLube™ compounds reduce friction in enclosed gear systems, ideal for high-load applications like worm drives.



EcoLube™ improves motion and durability in consumer mechanisms like blind rollers and seat latches, without PFAS.

ECOLUBE™ MD:

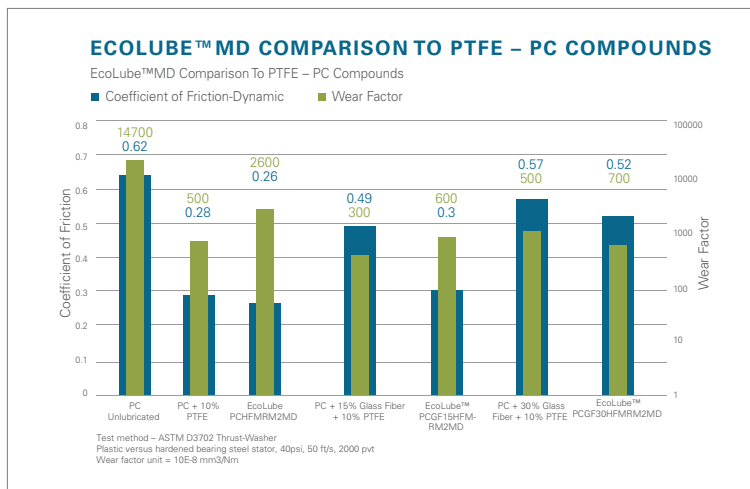
HEALTHCARE AND REGULATED APPLICATIONS

Healthcare applications operate under heightened validation and documentation requirements. Materials used in drug delivery devices, surgical instruments, and medical nonwovens must perform consistently under sterilization, repeated mechanical stress, and formal internal review processes.

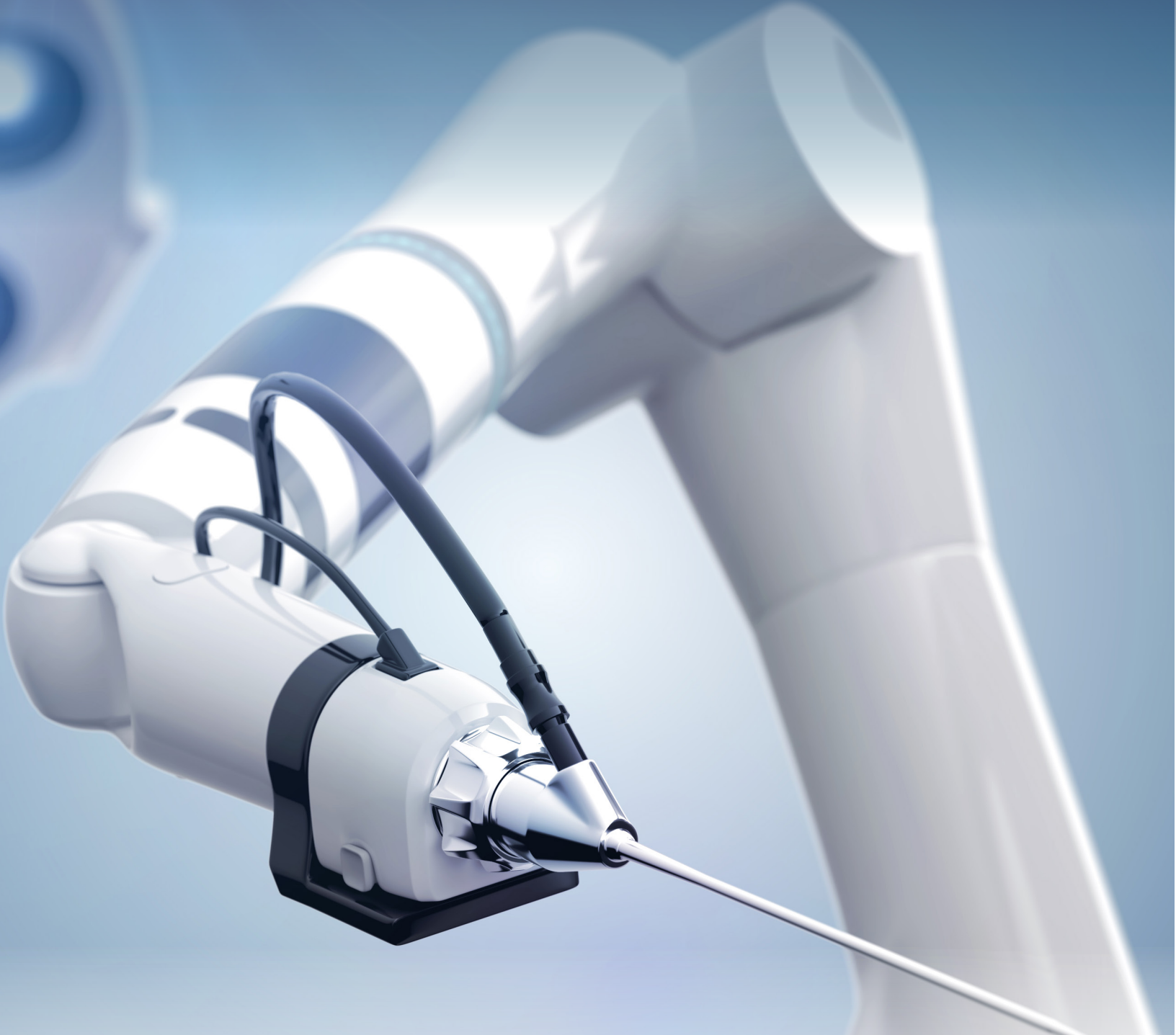
EcoLube™ MD represents a healthcare-focused subset of the EcoLube™ platform. These formulations are developed with controlled compositions and aligned with ISO 10993 biocompatibility requirements. By eliminating fluorinated additives while maintaining low-friction performance, EcoLube™ MD supports device designers seeking to reduce regulatory exposure while preserving predictable actuation behavior.

In medical nonwoven systems, nDrye™ enables durable alcohol resistance through in-melt integration, reducing reliance on surface-applied treatments that may degrade under repeated exposure. This supports barrier integrity in gowns, drapes, and protective materials while maintaining compatibility with defined production processes.

In regulated environments where material changes can trigger review from regulatory, quality, and sourcing teams, PFAS-free strategies must balance performance with formulation stability and documentation readiness.



EcoLube™ MD demonstrates validated low-friction and wear performance in PC compounds under ASTM D3702 testing, with similar performance achievable across engineering resins including PA66, POM, and others in regulated applications.



EcoLube™ Comparison to PTFE - PC Compounds

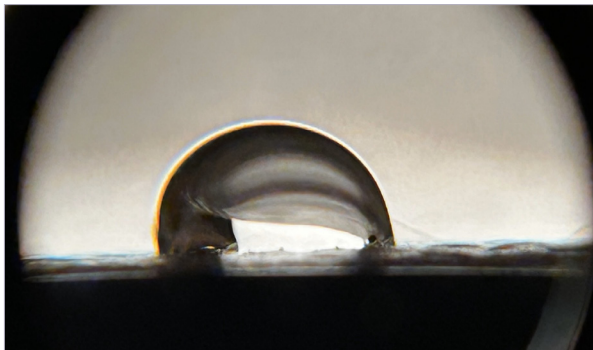
Test	Density	Notched Izod Impact Strength	Tensile Strength	Flexural Modulus
Method	ASTM D792	ASTM D256	ASTM D638	ASTM D790
Units	g/cm ³	ft-lbs./in.	psi	psi
PC + 10% PTFE	1.26	1.89	8,500	374,000
EcoLube™ PCHFMRM2MD	1.17	11.81	8,600	354,000
PC + 15% GF + 10% PTFE	1.37	2.82	11,400	721,000
EcoLube™ PCGF15HFMR2MD	1.27	2.94	12,000	720,000
PC + 30% GF + 10% PTFE	1.51	2.48	14,000	1,216,000
EcoLube™ PCGF30HFMR2MD	1.39	2.79	15,000	1,203,000

FIBER SYSTEMS

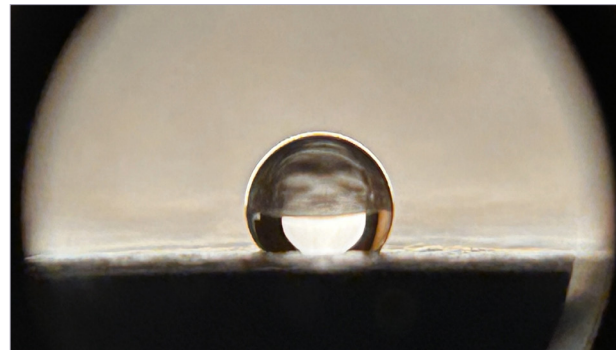
nDRYVE™ PFAS-FREE SURFACE PERFORMANCE

PFAS-based chemistries were historically used in fiber systems to reduce surface energy and repel fluids. Alcohol resistance is particularly challenging, as alcohol lowers surface tension and readily wets untreated polyolefin fibers.

nDryve™ is Americhem's PFAS in-melt surface-modifying technology platform optimized for polyolefin and engineering fiber systems. Integrated during melt processing, the additive becomes embedded within the fiber matrix, enabling durable multi-fluid repellency against alcohol and other low-surface-energy fluids without surface-applied treatments.



Control PP Fibers (NW): Lower contact angle; Increased wetting



PP Fibers (NW) + nDryve™ Hydrophobic Higher contact angle; Improved water repellency

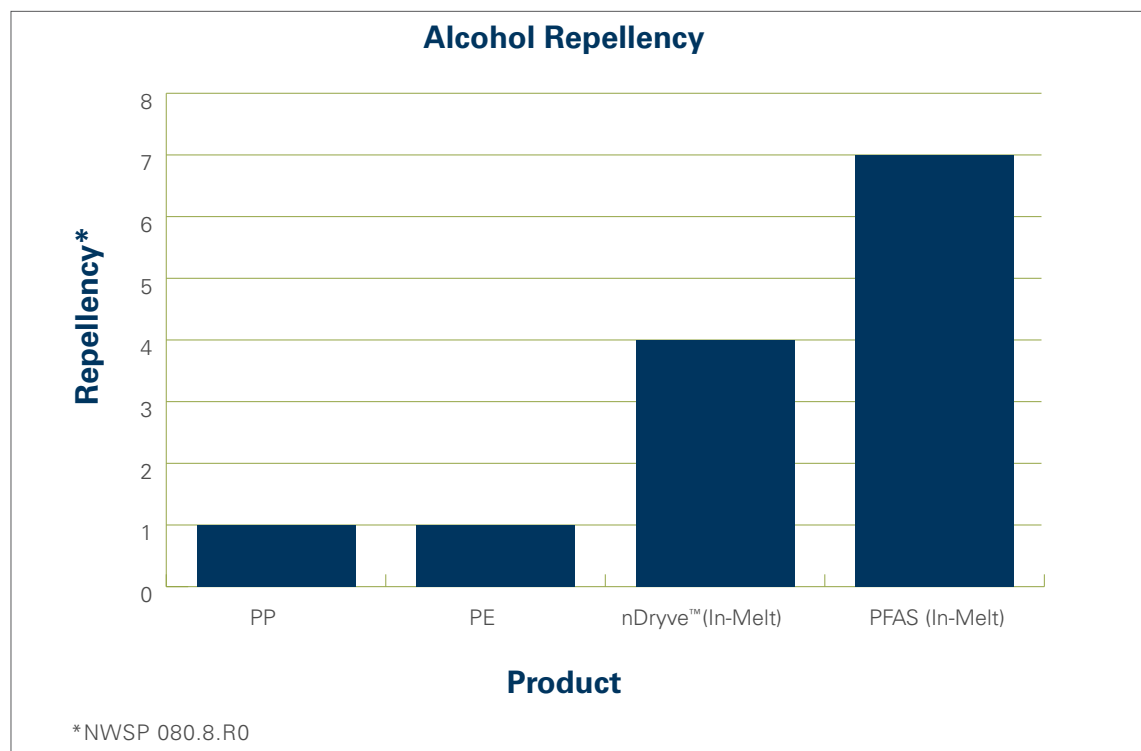
Standard Test Solutions		
Composition by Weight		
Alcohol Repellency Rating No.	% Alcohol*	%H2O
0	0	100
1	10	90
2	20	80
3	30	70
4	40	60
5	50	50
6	60	40
7	70	30
8	80	20
9	90	10
10	100	0

Alcohol repellency performance was evaluated using the NWSP 080.8.R0 test method.

Alcohol repellency testing demonstrates that nDryve™ delivers substantial improvement over untreated fibers and achieves application-relevant performance without fluorinated chemistry. Under AATCC TM193 Aqueous Liquid Repellency Test (water/alcohol solution resistance), nDryve™ achieves a Grade 6 rating. While fluorinated systems may achieve higher absolute alcohol repellency ratings, nDryve™ is engineered to meet defined performance thresholds required in many medical, hygiene, and industrial nonwoven applications.

Because surface functionality is engineered into the fiber itself, no secondary finishing step is required. This reduces variability associated with topical treatments and supports high-speed production compatibility. The platform is compatible with common synthetic fiber systems, including polypropylene, polyester, and polyamide, enabling flexible implementation across product lines.

nDryve™ Performance Data



Proven Hydrophobic Performance in PP Fibers

Product	Alcohol Repellency Rating
PP	1
PE	1
nDryve™ (In-Melt)	4 (40% IPA)
PFAS (In-Melt)	7

1. Alcohol Repellency Rating of nDryve™ (In-Melt) is 4 which corresponds to 40% IPA test solution.
2. Fibers containing nDryve™ demonstrate improved performance, achieving an alcohol repellency rating of 4 (40% IPA) under the NWSP 080.8.R0 test method; under AATCC TM193 Aqueous Liquid Repellency test conditions, this performance corresponds to a Grade 6.

Stain Resistance in Nylon Fiber Systems

Nylon fibers present higher staining susceptibility due to increased moisture absorption and surface polarity relative to polyester.

Under AATCC 175 testing, nDryve™-modified PA6 fibers demonstrate reduced stain uptake compared to untreated and cationic-treated controls, indicating improved resistance to acidic colorants under defined conditions.



Untreated nylon shows visible stain penetration, while nDryve™-modified fibers maintain reduced surface staining.

Hydrophobic Performance in Polyester Fibers

Untreated PET fibers exhibit higher surface energy, enabling rapid wetting by water and aqueous solutions.

nDryve™ reduces surface energy during melt processing, increasing contact angle and promoting visible water beading. This indicates improved resistance to fluid spreading without surface-applied treatments.



Control PET Fabric: No Water Repellency; Complete wetting observed



PET Fabric + nDryve™ Hydrophobic: Improved hydrophobic behavior with visible water beading



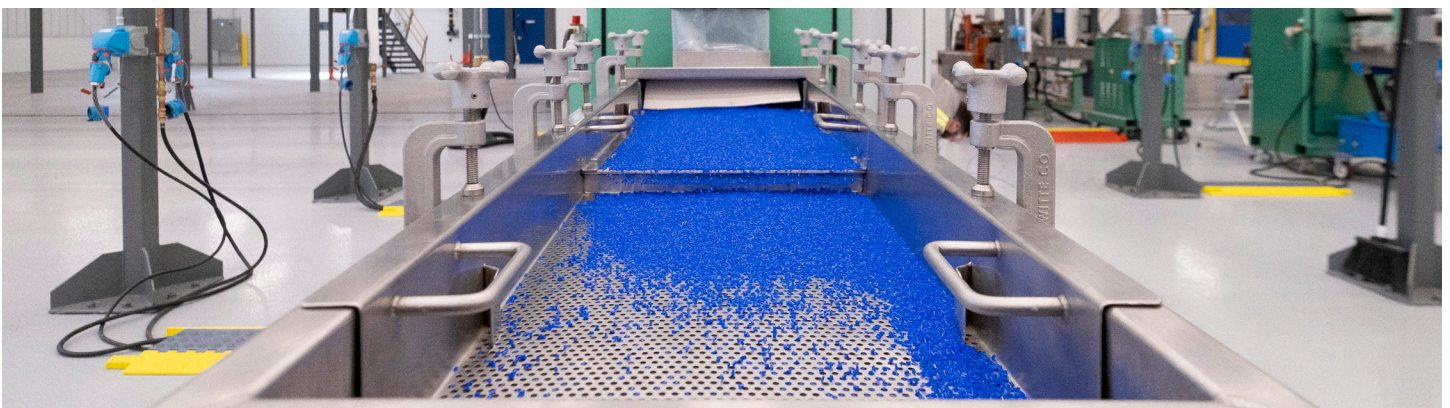
AMERICHEM'S APPROACH:

PLATFORM FLEXIBILITY AND COLLABORATIVE DEVELOPMENT

Transitioning away from PFAS requires more than alternative additives. It requires early collaboration across engineering, regulatory, and manufacturing stakeholders.

Americhem supports PFAS-free development through flexible compound and masterbatch platforms that span molded plastics and fiber systems. By evaluating wear conditions, surface requirements, processing constraints, and regulatory context early in the development cycle, Americhem works with customers to design material strategies that align with both performance and compliance objectives.

EcoLube™ and nDryve™ are not fixed solutions. They are adaptable technology platforms capable of addressing varied performance challenges across multiple base resins and global markets. This flexibility helps manufacturers manage regulatory uncertainty while maintaining technical integrity.



Controlled compounding environments and validated material handling enable Americhem to maintain material integrity and deliver consistent, repeatable performance across applications, including those with strict healthcare and regulatory requirements.

CONCLUSION

PFAS-enabled materials addressed complex engineering challenges in molded plastics and fiber systems. As regulatory oversight continues to expand globally, those performance functions must be rebuilt through intentional material architecture rather than direct substitution.

Through flexible technology platforms and application-specific development, EcoLube™ and nDryve™ demonstrate that tribological and surface performance can be engineered without fluorinated chemistries. By aligning material performance with regulatory durability, manufacturers can build resilient product strategies designed for evolving compliance expectations and long-term market stability.

MEET OUR AUTHORS

This whitepaper reflects the technical insights shared during Americhem's PFAS-focused webinar, led by members of our materials science and technical development teams.

With deep expertise in polymer compounding, additive engineering, and regulatory-driven material transitions, our presenters bring practical experience in designing PFAS-free solutions for both molded plastics and fiber systems. Their work spans tribological performance, surface energy modification, process optimization, and healthcare-grade material development.

Together, they represent Americhem's integrated approach to performance-driven, regulation-aware polymer design.



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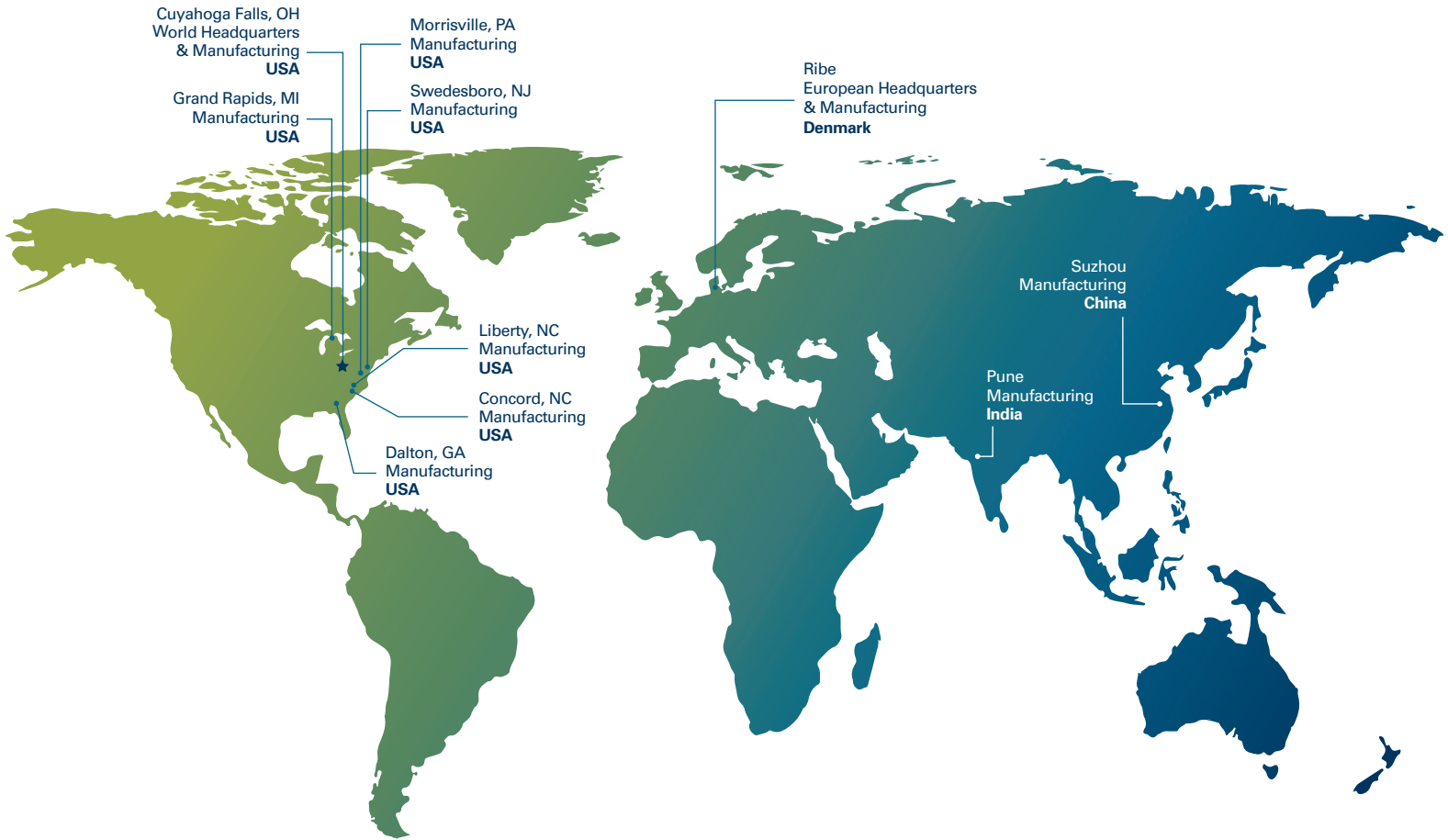
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PFAS REPLACEMENT DOES NOT HAVE A DROP-IN SUBSTITUTION. IT REQUIRES NEW DESIGN STRATEGIES AT THE MATERIAL LEVEL. AMERICHEM REBUILDS PERFORMANCE THROUGH ENGINEERED MATERIALS, ENABLING CONSISTENT RESULTS ACROSS MOLDED PLASTICS AND FIBER APPLICATIONS AS REGULATORY EXPECTATIONS CONTINUE TO EVOLVE.

A GLOBAL LEADER IN POLYMER SOLUTIONS



BATCH TO BATCH.
MARKET TO MARKET.
CONTINENT TO CONTINENT.

From our headquarters in Cuyahoga Falls, Ohio, to our manufacturing locations and sales offices across the world, our expansive footprint provides global reach for your organization's needs. Not only are we dedicated to getting your materials where they need to be, when they need to be there, we work behind the scenes to reduce your supply risks. In addition to our network of plants, regulatory and compliance teams, we have contingency plans and support services in place to secure your product against unforeseen interruptions.



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