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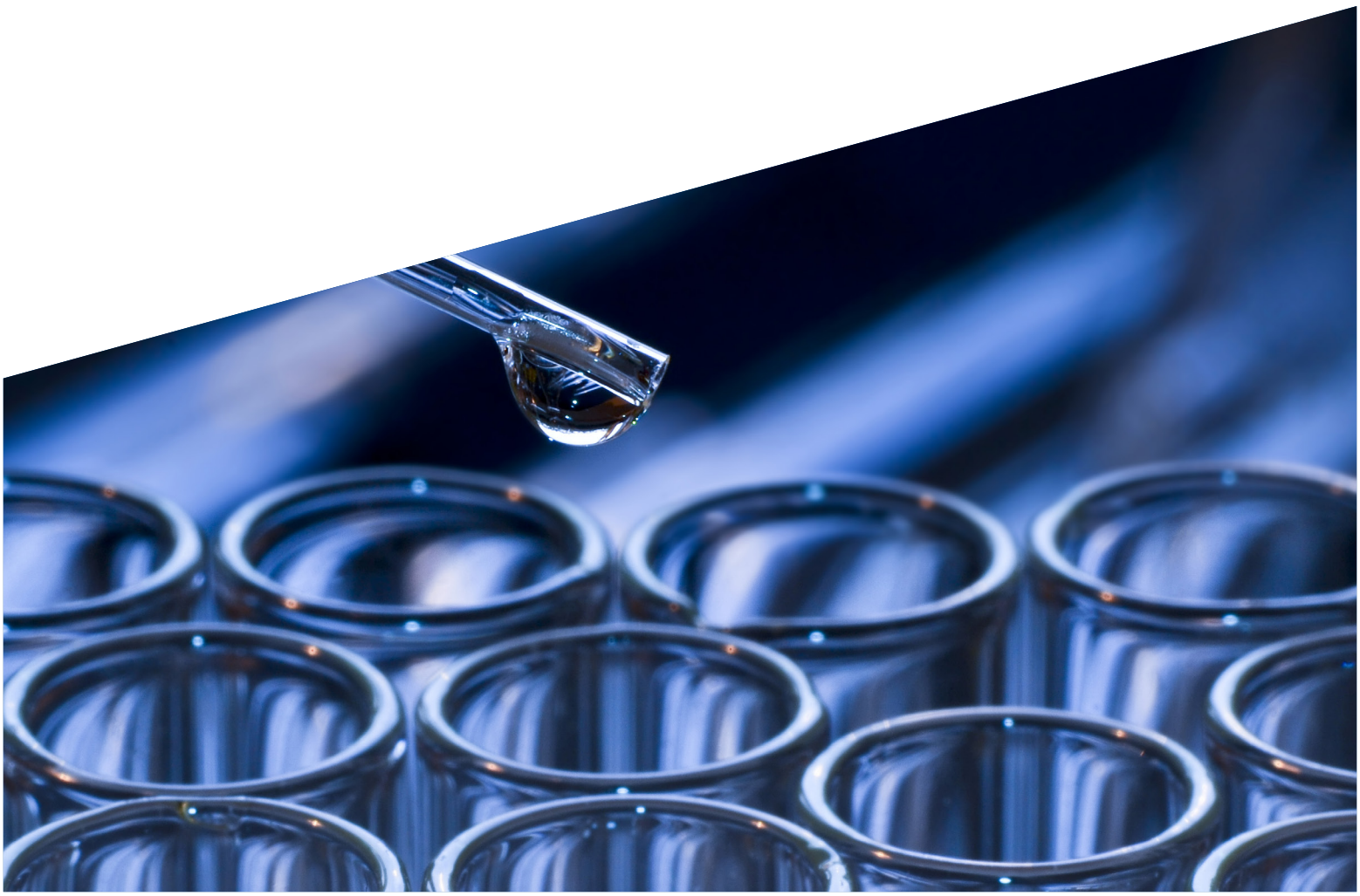
Your Dreams, Our Challenge

FREQUENTLY ASKED QUESTIONS about Fluoropolymers



FREQUENTLY ASKED QUESTIONS ABOUT FLUOROPOLYMERS

Fluoropolymers are highly versatile polymers that are used in a wide range of applications because they provide unique and desirable characteristics. As a leading global supplier of fluoropolymers and related products, we wanted to share with you the answers to some of our most frequently asked questions.

Q: What are fluoropolymers (fluorotechnology)?

A: Fluorotechnology refers to the broad range of technologies that utilize the unique element fluorine. These technologies offer unmatched thermal and chemical stability, providing reliable strength, resilience, and durability to modern products and components. Compared to other polymers, fluoropolymers are more expensive and their consumption is growing at a higher rate. However, they offer unmatched performance.

Q: When were the first fluoropolymers developed and by whom?

A: The first company to develop fluoropolymers for commercial purposes was DuPont. Its cookware brand Teflon™ has become a household name due to its unique nonstick characteristics. DuPont PhD Roy J. Plunkett discovered it accidentally in 1938. He had been working with tetrafluoroethylene gas when he noticed that the previously pressurized cylinder that he had been working with had lost all pressure. Inside, he found a white substance that was similar to tetrafluoroethylene, but once analyzed it was determined to be a brand new polymer.

Today, there are many companies that create fluoropolymers and products that use them. AGC entered the market in the 1970s with oil and water repellents and fluorinated resins, added PTFE resins in the 1980s, and added specialty products in the 2000s including fluoroelastomers, ETFE film and anti-fingerprint coatings. Today, AGC is the largest company that solely specializes in fluoropolymers.

Q: What are the different types of fluoropolymers?

A: The three main types are fluoroelastomers, homopolymers and copolymers.

- **Fluoroelastomers** are a subset of fluoropolymers that do not crystalize. These synthetic rubbers have extensive flexibility and stretchability and can easily return to their original shape when released. They are ideal for use in industries such as:
    - Oil and gas
    - Chemical processing
    - Automotive
    - Heavy-duty diesel
    - Wire and cable
    - Food handling and pharmaceutical

- **Homopolymers** are made from one specific monomer and are sold in a granular or powder form. Polytetrafluoroethylene (PTFE) is a popular homopolymer and makes up approximately 60–80% of the world's fluoropolymer production on a weight basis. This is because PTFE offers highly sought-after properties such as high-temperature resistance, inertness to almost all chemicals, good resistance to most solvents and weather resistance. The largest application for PTFE is in electrical insulation. It is also used extensively in the chemical process industry where corrosion resistance is needed: coating pipes, tubing and gaskets. Another major use is architectural fabric: PTFE-coated fiberglass cloth used for stadium roofs.

- **Copolymers** are made from multiple specific monomers that are bonded together to give the material additional qualities. Perfluoroalkyl polymer (PFA) is a popular copolymer because it can be used in a wide range of temperatures without losing its excellent chemical, mechanical, electrical and surface properties. PFA resins are similar to PTFE resins; however, PFA resins can be processed using conventional thermoplastic techniques like extrusion molding and injection molding. ETFE resins are melt-processable copolymers with superior physical toughness and resistance to chemicals, UV and extreme temperatures. These benefits make ETFE resins ideally suited for a wide range of high-performance products and components like industrial wiring and electronics. They are available in pellet or powder form for processing using conventional methods like extrusion molding and injection molding.

Q: How do fluoropolymers improve coatings?

A: Coatings made with fluoropolymer resins are ultra-weatherable and maintain their excellent appearance on buildings, bridges and other structures, as well as on aircraft, automobiles and solar panels. They can protect steel, aluminum and concrete from degradation by UV light, wind and rain, and corrosion. AGC's LUMIFLON® FEVE resins are transparent fluoropolymer resins that can be used to make both clear and pigmented coatings that offer substantial life cycle cost savings over conventional coatings.

Q: How do fluoropolymers improve nonwoven fabrics?

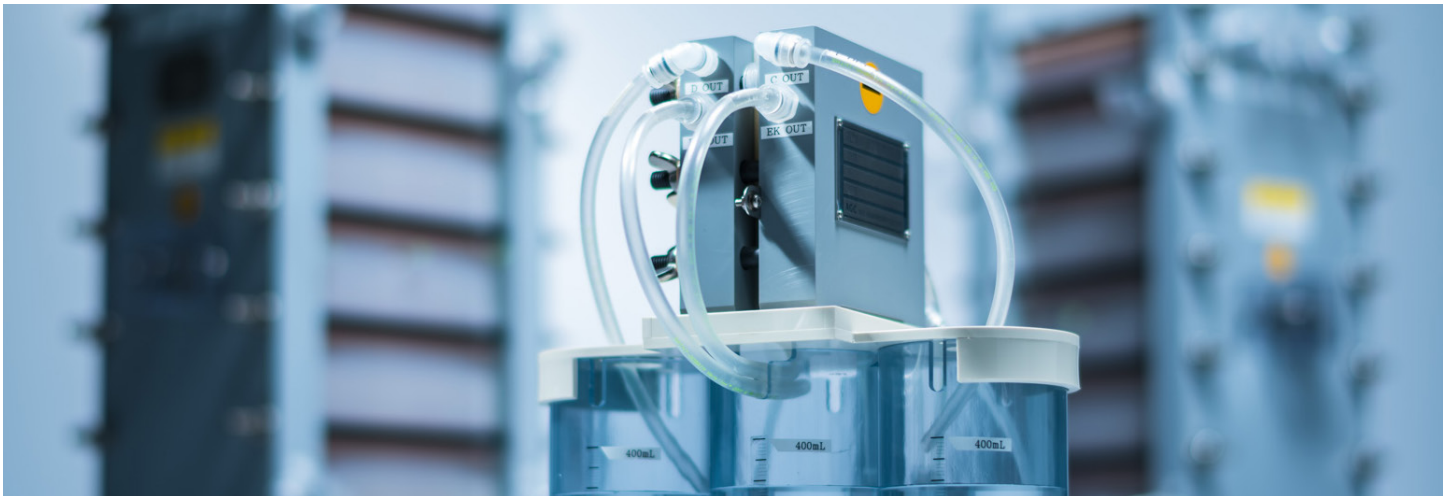
A: Fluoropolymers provide durable repellency to technical textiles and nonwovens. When fabrics are coated with them, the result is a breathable, low-friction finish that repels water and releases stains. This is due to surface energy. Low-energy surfaces will repel substances with higher surface tension. Fluorinated repellents impart a very low-energy coating to surfaces, making the surface able to repel water as well as highly permeable liquids like oils, solvents and chemicals. Fluoropolymer-based repellents are nonflammable, odorless and transparent when treated. They can be applied to nonwoven materials before or after installation and are compatible with auxiliary agents.

Q: How is fluorotechnology used in adhesives and sealants?

A: ETFE and PFAs can be compounded to provide adhesive properties that are compatible with many different materials including polyethylenes, metals and polyamide polymers like nylon 12. Though they adhere to the base materials, they resist permeation from harsh fluids and gasses. This makes them attractive for automotive parts and components. For example, there are fluoro-based adhesives that can chemically adhere to dissimilar materials, reduce weight and eliminate tie layers in multilayer hose constructions. They are ideal for constructions that require unsurpassed conductivity levels, chemical and permeation resistance, and protection against static buildup. Some perfluoro resins can even eliminate the need for surface treatment or a separate adhesive layer.

Q: What are enhanced fluoropolymer compounds and what are they used for?

A: PTFE resins can be compounded with pigments and fillers such as glass, carbon, graphite and metals to achieve superior performance properties. For example, adding glass fillers can enable the material to be used in extreme temperatures (from -268 °C to +260 °C) and exposed to extreme corrosives like liquid oxygen and fuming nitric acid. They can hold up in applications like wear pads for railway cars and self-lubricating compressor rings for nonaluminum cylinders. Properties include enhanced wear resistance, creep resistance, thermal conductivity and electrical conductivity. Even when fillers are added, the PTFE materials retain their low coefficient of friction, excellent chemical resistance and a wide service temperature range.



Q: How do fluorinated cleaning solvents compare to traditional cleaning agents?

A: Fluorinated cleaning solvents (also called fluorosolvents) are generally used to clean high-value electronics and critical metal components used in the medical device, automotive and aerospace industries. They have a higher unit price than aqueous cleaning, n-propyl bromide and chlorinated solvents, but often have reduced long-term costs and associated risks. Compared with aqueous cleaners, fluorosolvents have lower surface tension, provide superior cleaning power, and are better able to get into tight spaces. Compared with nPB and chlorinated solvents, fluorosolvents have no pungent smell, are nontoxic and nonflammable, are more environmentally friendly and are more compatible with plastics.

Q: Can fluoropolymer technology be used in place of architectural glass?

A: Yes. Films made from fluoropolymers (called ETFE films) are used around the world in architectural projects and greenhouses because they are safer and lighter than glass. ETFE film requires less structural support, which reduces building time and costs. The material is heat resistant, chemical resistant and fire resistant with excellent thermal insulation properties, high light transmission and long-term weatherability. Its high level of heat retention, combined with its ability to allow in more natural light than glass, can reduce energy costs by up to 30% compared to glass.

Despite being lighter than glass, ETFE film will not easily rip or scratch over time, even in the harshest environments. The film has a high tensile elongation (200 – 510%) and tear strength, as well as a thermal melting point of 260 °C and a linear thermal expansion coefficient of 9.4. Click here to see a comparison of ETFE film versus architectural glass.

Q: Can fluoropolymer technology be used for architectural fabrics?

A: Yes. Films made from fluoropolymers (called ETFE films) are used for architectural fabrics for tensile membrane structures like roofs, awnings, wraps and facades. Some of today's most exciting building designs include colorful and translucent textile skins. They not only increase the beauty and function of buildings, but provide UV and visible light transmission, insulation properties, durability and weather resistance. Click here to see a comparison of ETFE film versus other architectural fabrics.

Q: Are fluoropolymers safe?

A: Long chain fluoropolymers, called C8 fluorochemistry, are based on precursors to perfluorooctanic acid (PFOA). Concerns around byproducts of these chemistries, including PFOA and PFOS (perfluorooctanesulfonic acid), led the U.S. Environmental Protection Agency (EPA) to take action by passing the PFOA Stewardship Program, and these fluoropolymers are no longer manufactured or sold in the U.S.

AGC Chemicals has worked hard to develop a "new generation of fluorotechnology" with alternative short-chain fluorochemistry structures that have replaced the functions of older, long-chain fluorochemistry. The fluorotechnology that is currently produced in the United States, Europe and Japan has been well studied by industry, universities, government agencies and independent laboratories. Details from these studies have shown that the current chemistries offer significantly reduced bio-persistence and an improved environmental profile over the chemistries they replaced.

To learn more about fluoropolymers, or for help determining the right fluoropolymer for your application, **visit www.agcchem.com or contact an AGC product expert at 1-800-424-7833.**

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