Introduction to PVDF Coatings

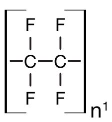
Hylar® 5000 PVDF

PVDF is the abbreviation for polyvinylidene fluoride, which can also be referred to as PVF2. This polymer is part of a class of materials known as fluorocarbons or fluoropolymers, which are characterized by high thermal stability and excellent chemical resistance.

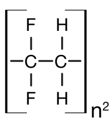
Fluoropolymers can be either fully fluorinated or partially fluorinated. In fully fluorinated polymers, fluorine atoms completely surround the carbon atoms forming carbon-fluorine bonds. Partially fluorinated polymers have both carbon-fluorine bonds and carbon-hydrogen bonds, thus the fluorine partially surrounds the carbon atoms.

Carbon-fluorine bonds are the strongest chemical bonds known and are responsible for the unique properties of fluoropolymers. The combination of carbon-fluorine bonds (provide stability) and carbon-hydrogen bonds (provide solubility) found in PVDF make this unique material wellsuited for use as a base polymer for liquid coatings.

The modification and copolymerization of fluorinated polymers can result in diverse properties, uses and applications. For example, PVDF differs from PTFE (polytetrafluoroethylene) in that two carbon-fluorine bonds have been replaced with two carbon-hydrogen bonds, as shown below.



PTFE



PVDF

Manufacturing PVDF

PVDF is produced by the emulsion polymerization of vinylidene fluoride monomer in the presence of other raw materials. The process, first developed in the 1940s, was commercialized by Pennwalt in the 1960s and later optimized by Solvay.

Each step of the process is carefully monitored by a Distributed Control System and specific quality control inspection criteria. The resulting micronized product is typically supplied in 500-lb bulk bags. All research, development, manufacturing, marketing, and distribution activities are ISO 9001:2000 certified in order to ensure the highest level of quality and consistency.

Coating Grades and Applications

The Hylar® PVDF grade used depends on the end-use application. Hylar® 5000 is used to produce architectural coatings for the pre-paint market and is supplied only to approved licensees. Hylar® 301F is unrestricted in its distribution, to the extent that the end use is non-architectural.

Hylar® 301F is suitable for a wide variety of markets, including formulations for non-architectural paints. PVDF's corrosion and chemical resistance make it an excellent choice for coatings used in automotive brake tubes and on underbody fasteners. Its electrical properties and particle size make it an ideal carrier for toner applications and coating for copier blades. PVDF can also been used as a thickener for liquid fluorinated greases.

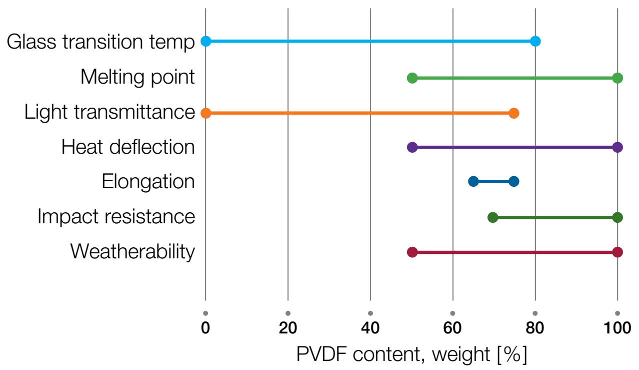
Hylar® 5000 Licensing Program

Architectural coatings based on Hylar® 5000 are available only through approved licensees in order to ensure product quality and integrity. Applicants must submit to a rigorous qualification process to demonstrate their production capabilities, quality assurance procedures, and technical expertise. Only the best coating manufacturers can become Hylar® 5000 licensees.

Producing Hylar® 5000 Coatings

Hylar® 5000 PVDF, which is supplied in a powdered form, is the key ingredient in the formulation of premium architectural coatings. Hylar® 5000 and acrylic resin are used to form the base that manufacturers use to prepare their coatings systems. A liquid coating is produced by dispersing Hylar® 5000 powder under very high shear into a blend of acrylic and solvents. This dispersion is unaffected by ambient temperature; however, when heated, the powder particles dissolve and coalesce. By manipulating the solvent balance, a stable dispersion is produced that can be handled and applied much like standard liquid coatings, and then heat-cured into adherent integral films.

Figure 1: Performance of PVDF-acrylic blends



Solvay works closely with its licensees, sharing its technological resources and experience. For optimum coating performance, the Hylar® 5000 licensing agreement requires that a minimum of 70% PVDF is used as part of the total resin system and a minimum of 40% PVDF is used as part of the total solids content. As shown in Figure 1, PVDF to acrylic in a 70:30 ratio provides the ideal balance of coating weatherability, hardness, flexibility and clarity.

The coatings formulation includes other ingredients, such as pigments for color and opacity. In addition, modifiers and additives may be added to achieve a variety of specific properties.

Pigmentation Requirements

Since PVDF is transparent to and unaffected by ultraviolet (UV) radiation, the pigment used in a PVDF coating must be opaque in order to protect the substrate from the sun's damaging UV radiation. To compliment the stability of PVDF, pigments should also be resistant to heat (since the coating is baked), chemicals and weathering. In general, inorganic color compounds, often known as ceramic pigments, exhibit these properties.

Applying Hylar® 5000 Coatings

In most cases, the metal substrate is aluminum or galvanized steel that meets high standards of uniformity and quality. Cleaning, preparation and chemical pretreatment of the metal is used to present the best possible surface for receiving the finished system. Primers, for instance, are used to impart adhesion and corrosion resistance. A Hylar® 5000 coating applied to properly prepared metal delivers exceptional performance for many years to come.

Formulations are tailored to the application method, which is usually coil or spray coating. With either method, the coated metal must undergo a baking process, which coalesces the PVDF resin particles, fuses them together, and evaporates the solvent.

Exceeds AAMA 2605 Requirements

Exposure to weather affects the appearance of coatings in several ways, including color change, gloss deterioration and chalking (a form of surface erosion.) These changes can be quantified and used to show the superior performance of PVDF coatings versus competitive coatings.

Coatings formulated with 70% PVDF are the only coatings proven to consistently surpass the AAMA 2605 requirements for Superior Performing Organic Coatings – the highest performance standard in the industry. For more details on the performance of PVDF coatings compared with other resin systems, please see Solvay's technical bulletin entitled Long -Term Performance of Architectural Coatings.

Proven Performance

Today more than ever, architects around the world appreciate the benefits of Hylar® 5000 coatings and specify these advanced coatings for monumental, industrial and commercial applications. Structures coated with Hylar® 5000 coatings over 40 years ago still have their original beauty and appearance, showing that PVDF-based coatings deliver reliable, long-lasting performance in real world conditions.

Environmental Benefits

PVDF coatings are a proven way to reduce energy usage and costs. They stay attractive longer than any other architectural coating because they resist environmental forces that can attack lower-performing products. Since they keep their good looks and continue to protect their substrates, the refinishing that is necessary with lower-performing coatings is avoided.

Hylar® 5000 is a critical component of coatings used in cool metal roofing systems. Solvay's licensees use inorganic pigments to produce coatings with high solar reflectance. The increased reflectance of infrared radiation reduces surface temperature and heat load via conduction into the building. As a result, cooling requirements can be dramatically reduced, lowering electricity consumption and leading to reduced emissions and improvements in the environment.

Cool metal roofs prepared with Hylar® 5000 PVDF coatings systems retain their solar reflectance longer than other paint systems due to the coatings superior resistance to photo-chemical degradation and excellent dirt shedding. More information on this topic is available at www.coolmetalroofing.org.

Table 1: AAMA 2605 performance

Performance Test	AAMA 2605
Minimum film thickness	1.2 mils
Crosshatch adhesion	Dry, wet and boiling 100%
Direct impact resistance	0.1 inch deformation, minor crack/no pick-off
HCl resistance (10%)	15-minute spot, no blister or color change
Mortar resistance	24-hour surface contact, no adhesion or residue
Detergent resistance	72-hour immersion, no change or loss of adhesion
Humidity resistance	4,000 hours 100% humidity #8 blister size maximum
Salt spray resistance scribed	4,000 hours 5% solution, minimum 7 on scribe, 8 on field
Pencil hardness	F (minimum)
Abrasion resistance (1/mil)	40 (minimum)
Nitric acid vapor resistance	30-minute exposure, <5ΔE color change
Window cleaner resistance	24-hour spot test, no visual change
Weathering	10 years Florida: <5ΔE maximum color change; 50% gloss retention minimum; 8 chalk minimum (6 on whites); 10% film erosion maximum

www.solvay.com

SpecialtyPolymers.EMEA@solvay.com | Europe, Middle East and Africa
SpecialtyPolymers.Americas@solvay.com | Americas
SpecialtyPolymers.Asia@solvay.com | Asia Pacific

SOLVAY
asking more from chemistry®