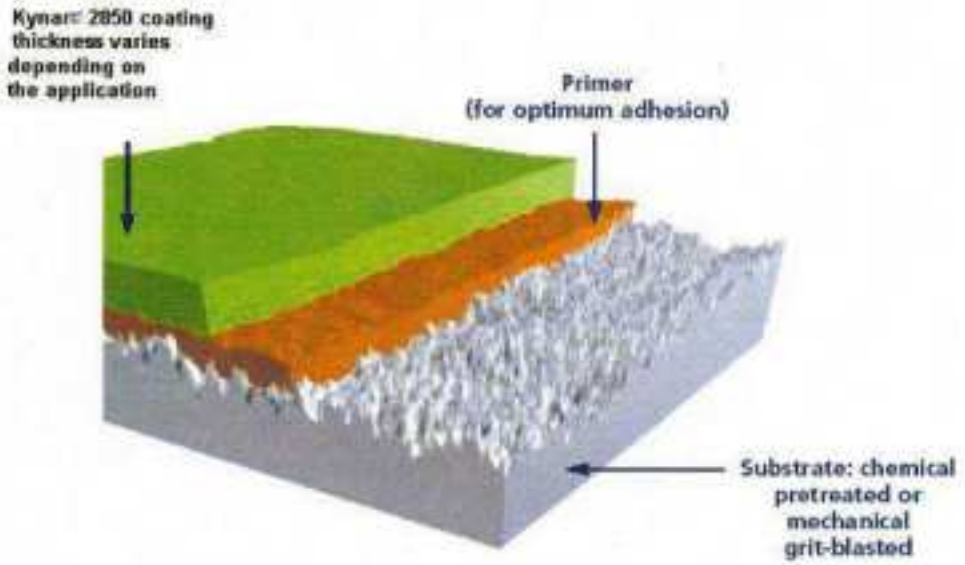
ATOFINA

Kynar® FLEX 2850 PC Powder Coating Data

The Kynar® Flex 2850 PC Powder Coating System is a dual layers protection ensuring optimum protection to the metal substrate.



KYNAR FLEX® 2850 PC POWDER COATING

KYNAR FLEX 2850 PC is a powder grade, semi-crystalline based copolymer made of vinylidene fluoride and hexafluoropropylene.

KYNAR FLEX 2850 PC has been specifically designed for use in powder coating applications in conjunction with the KYNAR FLEX 2850 powder primer. It is typical of other KYNAR PVDF grades, but has a higher flexibility approaching that of KYNAR FLEX 2800-04.

KYNAR FLEX 2850 PC is easily processed and has excellent physical, mechanical, thermal and flame resistant characteristics. KYNAR FLEX 2850 meets the smoke and flame requirements of UL 910. This copolymer is the ideal choice for use as a powder coating. The KYNAR FLEX 2850 PC topcoat can be used for critical high purity applications, see regulatory information section of this document.

Other characteristics of KYNAR FLEX 2850 PC are:

- Excellent thermal stability
- Excellent abrasion resistance
- Excellent purity and chemical resistance
- Impervious to UV degradation
- Self extinguishing material
- Extremely low smoke emission characteristics
- Pigmentable

Degasifier internals courtesy FisherMoore, North Salt Lake City, Utah

KYNAR FLEX 2850 PC Powder Coating Regulatory Status

KYNAR FLEX 2850 PC Powder Coating complies with United States Pharmacopoeia (USP) Classification VI.

KYNAR FLEX 2850 PC Powder Coating copolymer resin may be safely used in articles intended for repeated contact with food per Title 21, Code of Federal Regulations, Chapter 1, part 177.2600.

Centrifuge housing courtesy FisherMoore, North Salt Lake City, Utah

Kynar® PVDF为线缆应用带来的特性

- 耐高温，最高达到UL 150° C
- 天然阻燃，LOI (氧指数) 高
- 极低的烟雾值
- 优异的热稳定性(高温下保持很好的机械性能，电性能及抗化学性)
- 优异的抗化学性，及其耐受苛刻的腐蚀环境
- 加工方便，适合注塑和挤出熔融加工
- 可辐照交联，进一步提升耐热性
- 和其它氟聚合物相比带来更优的性价比
- 不同的应用提供不同的规格选择
  - 不同机械强度、柔韧性及氧指数的规格牌号供选择
  - 另有发泡规格，带来轻量化的解决方案

KYNAR
ARKEMA

KYNAR® and KYNAR FLEX® PVDF (I)

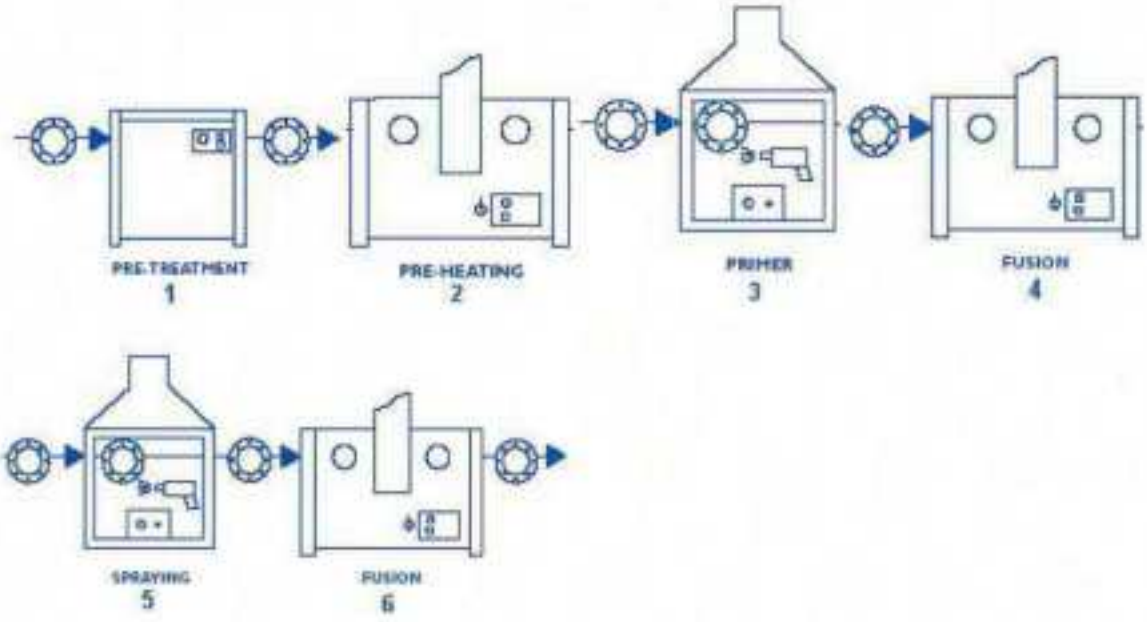
- Kynar polyvinylidene fluoride is a tough engineering thermoplastic that offers a unique balance of performance properties :
  - Resistant to most chemicals and solvents
  - Resistant to ultraviolet and nuclear radiation
  - Resistant to weathering
  - Resistant to fungi
  - Low permeability to most gases and liquids
  - Low flame and smoke characteristics
  - Mechanical strength and toughness
  - High abrasion resistance
  - High thermal stability
  - High dielectric strength
  - High purity
  - Readily melt processible
  - Rigid and Flexible versions of Kynar® PVDF are available
- A material of choice in many different applications :
  - Chemical Processing Industry (CPI)
  - Architectural coatings
  - Cables
  - Foams
  - Filtration membranes
  - Batteries
  - etc ...

KYNAR® and KYNAR FLEX® PVDF (II)

TECHNICAL DATA FOR KYNAR FLEX® 2850 PC PELLETS

	METHOD	CONDITIONS	COMMON UNITS	VALUE
PHYSICAL PROPERTIES				
Specific Gravity	D792	-	-	1.76 - 1.78
	ISO R1183D	-	-	1.76-1.78
Melting Temperature	D3418	-	°F	311 - 320
	ISO 3416C	-	°C	158
Refractive Index	D542	at Sodium D line, 77°F	-	1.42
Water Absorption	D570	at 77°F, 24 hours	%	0.04
Nature	ISO 12086	-	-	VDF/HFP-K
THERMAL PROPERTIES				
Coefficient of Linear Thermal Expansion	D696	-	$°F^{-1}$	7.8×10^{-5}
Deflection Temperature	D648	at 66 psi	°F	140 - 167
Deflection Temperature	D648	at 264 psi	°F	100 - 131
Deflection Temperature	ISO 75	at 1.80 MPa	°C	72
FLAMMABILITY				
Limiting Oxygen Index	D2863	-	%	42
Thermal Decomposition	TGA	in air	°F	707
	1% wt. loss	in nitrogen	°F	770
Burning Rate	UL	Bulletin 94	-	V - O
MECHANICAL PROPERTIES				
Tensile Yield Strength	D638	23°C	MPa	35
	ISO R527	-	psi	4500 - 5500
Tensile Break Strength	D638	-	psi	4800 - 6000
Break Elongation	D638	-	%	300 - 400
	ISO R527	23°C	%	>50
Tensile Modulus	D638	-	psi	110000 - 140000
Flexural Modulus	D790	-	psi	160000 - 190000
	ISO 178	-	MPa	1000
Izod Impact Strength	D256	notched	ft-lb/in	2 - 6
	ISO 180	notched	J/m	214
Izod Impact Strength	D256	unnotched	ft-lb/in	No Break
Hardness	D2240	-	Shore D	70
ELECTRICAL PROPERTIES (at 77°F)				
Volume Resistivity	D257	DC	ohm-cm	2×10^{13}
Dielectric Constant	D150	100 Hz	-	9.0 - 10.0
		1 kHz	-	7.0 - 8.0
		100 kHz	-	7.0 - 8.5
Dissipation Factor	D150	100 Hz	-	.10 - .20
		1 kHz	-	.01 - .03
		100 kHz	-	.01 - .03

The Kynar® Flex 2850 Powder Coating process



KYNAR FLEX 2850 PC POWDER COATING PROCEDURE

1. Pretreatment

Surface preparation for application of KYNAR FLEX 2850 primer and topcoat is critical to the success of the application. All volatiles, dirt, grit and other contaminates must be removed from the surface to be coated. Blasting to remove scale, oxides, etc. and to provide an anchor pattern for the coating is recommended. The KYNAR FLEX 2850 powder primer is suitable for steel, stainless steel, aluminum and other common metallic substrates that are capable of withstanding the 260°C (500°F) oven temperature.

Note: *Closed pockets within the part to be coated should be vented to prevent possible pressure buildup during baking.*

Centrifuge basket courtesy FisherMoore, North Salt Lake City, Utah

Glovebox courtesy FisherIMoore, North Salt Lake City, Utah

2. Preheat

Preheat the metal substrate in a clean oven to the predetermined temperature for application of the primer.

3. Primer coat

Remove the part from the oven and apply the KYNAR FLEX 2850 primer to the hot part to the desired thickness. It is important to cover the surface with a uniform thickness of primer.

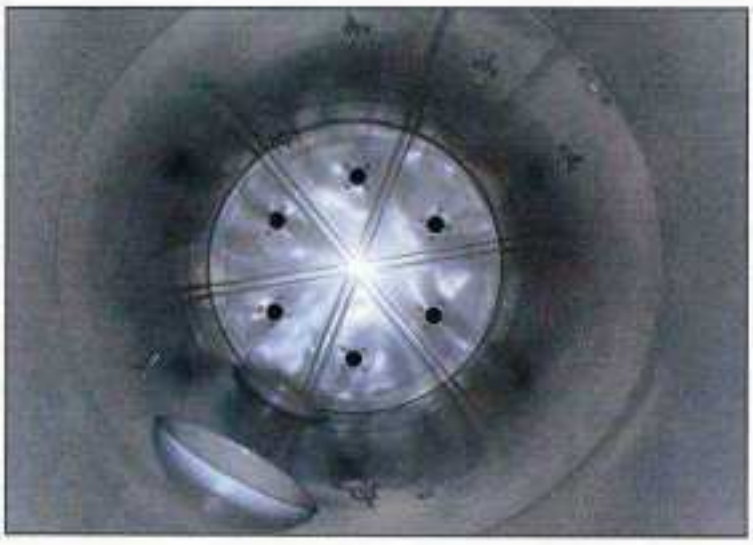
4. Fusion

Return KYNAR FLEX 2850 primed part to a hot oven. When proper flow out is obtained the KYNAR FLEX 2850 primer surface appears wet.

Note: *Excessive flow out time and/or coating thickness may result in sagging of the coating.*

5. Topcoat

Remove the part from the oven, rotate the part to prevent sagging and apply the KYNAR FLEX 2850 PC powder topcoat to the hot part. Apply 3-4 **light** passes of KYNAR FLEX 2850 PC topcoat. Excessive deposition of topcoat will result in the powder falling off the part and/or bubbles in the coating.



Degasifier courtesy FisherIMoore, North Salt Lake City, Utah

6. Fusion

Return the part to oven for flow out.

Note: *The coating may appear rough or pitted as the first topcoats are applied. To obtain a smooth surface apply thin coats of KYNAR FLEX 2850 PC topcoat until the surface appears smooth. This should occur by the third application of the KYNAR FLEX 2850 PC topcoat. Heavier coats of KYNAR FLEX 2850 PC topcoat can be applied after the smooth surface is obtained. Excessive thickness of powder will result in air entrapment within the finished coating.*

7. Build-up

Repeat the application of the KYNAR FLEX 2850 PC topcoat and oven flow out, steps 4 and 5, until the desired coating thickness is obtained. It is important to rotate the part to prevent sagging. Improved gloss and smoothness can be obtained by allowing the part to remain in the oven longer during the final flow out cycle.

The part should be rotated for each coat or continually to prevent sagging or dripping.

Vacuum degasifier 11 Meters long X 2 Meters diameter KYNAR 2850 PC coated internally by FisherMoore, North Salt Lake City, Utah for a major chip manufacturer to provide purity and reliability.

Kynar® & Kynar Flex®耐化学性

Kynar® & Kynar Flex®提供了卓越的耐化学性

化学品名	浓度	温度	备注
硝酸	71% 溶液	50 °C	A
硫酸	96% 溶液	室温	A,D
盐酸	37% 溶液	室温	A,B
氢氟酸	49% 溶液	室温	A
醋酸	50% 溶液	室温	A
氢氧化钠	10% 溶液	90°C	C
氢氧化铵	30% 溶液	室温	C
次氯酸钠	5% 溶液	室温	A
液溴		室温	A
碘	10% 溶液	室温	A
乙烯基乙二醇	100% 溶液	室温	A
甲苯	100% 溶液	29°C	C
甲基-氯仿	100% 溶液	50°C	A
庚烷	100% 溶液	90°C	A
乙醇	100% 溶液	21°C	E
二乙基醚	100% 溶液	0°C	A
丙酮	10% 溶液	13°C	C
燃料C		室温	A

A. 无变化

B. 38° C 12周后有变色现象，物理性能包括延伸率、拉伸强度和重量变化很小或没有.

C.在所示温度下表面变黑, 少许或无物理性能变化

D. 90%浓度18 ° C下6周后有颜色变化，少许或无物理性能变化

E. 12周后表面变黑, 少许或无物理性能变化

KYNAR

Kynar® & Kynar Flex®耐磨性

- Kynar®提供了优异的耐磨性，从而带来更好的抗切割性

材料	耐磨性 (CS-10环，负载1 Kg, mg/1000次循环)
NYLON 6-10*	5
UHMW PE	5
KYNAR	5 - 10
CTFE	13
PVC (Rigid)	12 -20
Polypropylene (PP)	15 - 20
CPVC	20
Polystyrene (PS)	20-40
Stainless Steel 304	50
ABS	60 - 80
PTFE**	500 - 1000

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Fungal, Chemical, and Fire Resistance of PVDF Foams and Polymers

Ron Partridge

Today's cleanroom environments in the pharmaceutical and semiconductor markets require the highest level of material performance across a broad spectrum of requirements. New, sophisticated medicines are made using advanced manufacturing technologies and materials. High technology cleanroom environments often contain polymeric sheets, coatings, wall coverings, and polymeric foam for insulation. These are used to create lightweight structures, walls, partitions, ceilings, and pipe and ducting insulation.

In general, fluoropolymers and, in particular, films, coatings, and insulating foams made from polyvinylidene fluoride (PVDF) do not support the growth of mold. Covering exposed surfaces with PVDF polymer provides a high-purity "inert" surface which does not support the growth of microorganisms and provides the resistance needed to withstand the harsh chemicals used for cleaning and sterilization. Fluoropolymer-based paints and solution coatings offer another option for cleanroom designers because these coatings resist fungal growth as well.

Fungal and microbial growth resistance is very important in cleanroom environments, but also important are fire resistance and low smoke generation, low moisture absorption, insulating properties, abrasion resistance, and non-shedding properties to prevent the introduction of contaminants into the manufacturing process.

ANTIFUNGAL PROPERTIES

Low surface energy makes it difficult for mold to grow on the surface of foam insulation. Tested according to *ASTM G21-96 (2002), Standard Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi*, such foams showed no observed growth after the required 28-day exposure. This result was also confirmed by microscopic examination.

Pure synthetic polymers are usually fungus-resistant because they offer no carbon source for the growth of fungi. Unfortunately, polymer additives such as plasticizers, cellulosics, lubricants, stabilizers, and colorants often permit fungal attack of plastic materials. PVDF contains no plasticizers or other process additives, is inherently very pure, hydrophobic, and resists microbial attack, even under conditions favorable for such attack, namely, temperatures from 2–38 °C (35–100 °F) and relative humidity from 60 to 100%.

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FUNGUS	Fungus Sources Identification No.			
	NRRL	DSM Germany	ATCC USA	IMI Strain No.
Aspergillus niger	3536	63263	9642	091855
Aureobasidium pullulans			15233	045533
Chaetomium globosum	1870	1962	6205	045550
Gliocladium virens	2314	1963	9645	045553
Penicillium funiculosum			11797	211742

Table 1: ASTM G21-96 (2002) Standard practice for determining resistance of synthetic polymeric materials to fungi. Testing was conducted by Zoteofoams Plc.

Table 1 shows the organisms that were used for the testing.

FIRE RESISTANCE

Today's pharmaceutical companies have large investments in development, testing, FDA approval, and production of drugs. Even slight delays in production can result in financial losses. The financial impact of fire or smoke damage to a manufacturing facility can be very significant.

In order to limit the risk due to fire and smoke, Factory Mutual (FM), Underwriters Laboratories (UL), ASTM, and other testing agencies have developed fire-testing methods to characterize the fire performance of materials. For cleanroom materials, FM has established a fire and smoke standard called FM 4910 (Cleanroom Materials Flammability Test Protocol). This standard was developed to reduce the risk of fire and the resultant financial impact should one occur.

Many polymeric materials will readily burn, provide fuel to a fire, and produce large amounts of smoke. However, PVDF is inherently flame retardant without additives.

PVDF, in general, is characterized by the following:

- High auto ignition temperature
- Low caloric value
- Self extinguishes when a direct flame is removed
- Minimal fire propagation and minimal smoke generation
- Resistance to most chemicals, including typical sterilization methods
- High purity
- UV and gamma radiation resistant
- Toughness and cut-through resistance

ZOTEK® F42 HT LS foam, based on Kynar® PVDF resin, is the only polymeric foam to have achieved the 'Specification Tested' status against the FM 4910 test protocol. The foam has a high auto ignition temperature, minimal fire propagation and smoke generation, and low fuel load. The foam self-extinguishes when a direct flame is removed. It is hydrophobic and does not wick moisture, retaining its insulating properties in wet areas (unlike insulations which lose R value when they get wet). This specific grade of material is used to make T-Tubes® insulation, an insulation system specifically developed for cleanroom stainless steel process lines and equipment that also meets FM 4910 standards.

CHEMICAL RESISTANCE

Fluoropolymers exhibit exceptional chemical resistance and can withstand the harshest cleaning chemicals. PVDF is commonly used in solid sheet, as a foamed material, or in a solution coating.

PVDF resins are resistant to a wide range of chemicals, including most acids and acid mixtures, weak bases, halogens, halogenated solvents, hydrocarbons, alcohols, salts, and oxidants. At ambient temperatures, PVDF homopolymers are generally resistant to chemicals with a pH up to 12.

INSULATION PROPERTIES

For piping or process insulation, it is important that the materials used maintain their insulating properties over a wide range of temperatures and resist water absorption. Table 2 (on the next page) shows the R values for a specific foam insulation.

CONCLUSION

Materials should be chosen for the construction of cleanrooms that have excellent chemical and fire resistance and do not support the growth of fungi and other microbial

Grade	Testing Temperature [°C]	Thermal Conductivity		Thermal Resistance	
		k value metric [W/m.K]	*k* value imperial [Btu.in/ft2.h.°F]	*R* value metric [m2.K/W]	*R* value imperial [ft2.h.°F/Btu]
Zotek F42 HT LS	10	0.032	0.222	0.79	4.51
	50	0.037	0.256	0.69	3.9
	83	0.041	0.284	0.62	3.52
	130	0.053	0.367	0.48	2.72

Table 2: R value performance

species. Fluoropolymers offer many of these properties; PVDF has shown excellent fungal resistance and fire performance. Stringent cleaning and disinfection procedures are critical to controlling fungal contamination in the cleanroom environment. PVDF has inherent chemical resistance that withstands most aggressive chemical cleaning methods. It also provides excellent mechanical properties, abrasion resistance, and does not easily produce particulate contamination. Cleanroom surfaces can be coated with PVDF resin as a film laminate or solution coating.

Note: Kynar® PVDF and Kynar Flex® are registered trademarks of Arkema Inc. ZOTEK® F is a registered trademark of Zotefoams Plc. T-Tubes® is a registered trademark of UFP Technologies, Inc.

Ron Partridge is Senior Business Development Engineer at Arkema Inc., 2000 Market Street, Philadelphia, PA 19103. He can be reached at 215-419-7874; Ron.Partridge@Arkemagroup.com.

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Arkema Performance Polymers

Products and Selected Applications

3/7/2010

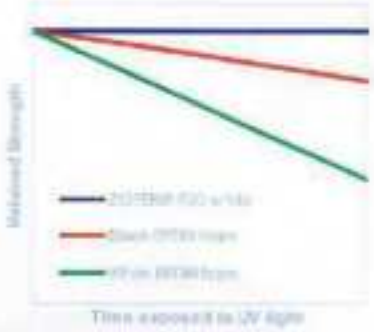
ARKEMA

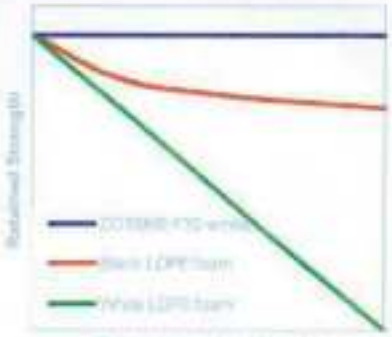
Kynar® PVDF Closed Cell Foams: From Zotefoams

3/7/2010

Kynar® PVDF - ZOTEK® F Properties

- Ultra-low Density
  - ✓ Density of 1.9 pcf or 0.03 g/cc for Zotek F30
  - ✓ Density of 2.4 pcf or 0.038 g/cc for Zotetek F38
- UV Resistant
  - ✓ Completely UV Stable
- Good insulator
  - ✓ Low thermal conductivity
  - ✓ Good acoustic insulator / vibration damping
- Water barrier
  - ✓ Low water absorption and water vapour permeability
- Low outgassing
  - ✓ Passes NASA Requirements





General Characteristics: Zotefoam Zotek® F

- Outstanding Fire Performance: Meets
  - FAR 25.853 (d) Aviation Heat Release and Smoke Density
  - FAR 25.856 (a) Radiant Heat Panel
  - FAR/CS 25.853 (a) Vertical Bunsen Burner FAR 25.856 Aviation Radiant Heat Panel
  - First foam insulation to pass FM 4910 Clean Room Flammability
  - FM 4924 Pipe Chase Flammability Standard (T-Tubes)
  - ASTM E-84 Burning Characteristics of Building Materials
  - UL 94 V0 Rating
- Insulation Properties
  - Low and stable R Value

Grade	Testing Temperature [°C]	Thermal Conductivity		Thermal Resistance	
		k-value metric [W/m.K]	k-value imperial [Btu.in/ft2.h.°F]	R-value metric [m2.K/W]	R-value imperial [ft2.h.°F/Btu]
Zotek F42 HT LS	10	0.032	0.222	0.79	4.51
	50	0.037	0.256	0.69	3.9
	83	0.041	0.284	0.62	3.52
	130	0.053	0.367	0.48	2.72

Technifab

- Zotek® F30 and F38 HT are qualified to BMS 8-371: Flexible PVDF Foam.
- Technifab is Sole Source for BAC 5362, Forming of Thermoplastic Foams.

Kynar® Foam Applications – For Boeing

- ✓ Pipe Insulation
- ✓Ducting
- ✓Flex Ducting
- ✓ Ductwork Connectors
- ✓ Window Seals

KYNAR®

防腐蝕的最佳產品

在化工行業之應用

Kynar

ARKEMA

阿科瑪-世界PVDF的領導者

- 我們有兩座生產工廠

Pierre Bénite – 法國

Calvert City – 美國

我們提供最完整的熱可塑性PVDF包含單一聚合物 (homopolymers) 與共聚合物(copolymers)

KYNAR® 爲阿科瑪公司所註冊之商標

Kynar®

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KYNAR® 一種具有吸引力的聚合物

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KYNAR® 主要的特性

- 最佳的耐化學性質
- 具有耐高溫以及高機械性質
- 高純淨度並具有平滑之表面
- 具有抗紫外線以及輻射之能力
- 具有非常好的耐磨耗性質
- 不易著火以及具有低煙特性
- 大部分氣體與溶液不易滲透
- 具有高熱穩定性以及成型較爲容易

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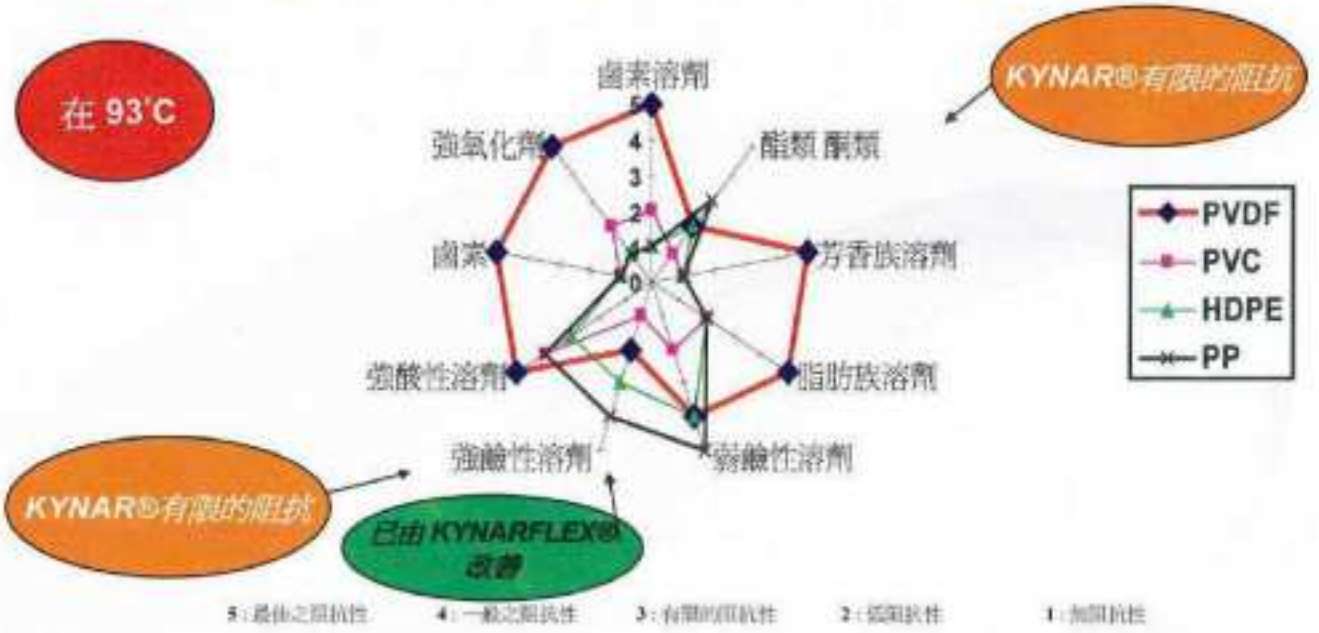
KYNAR® 抗化學性

以下爲 **KYNAR®** PVDF 與其他塑料的抗化學性比較圖



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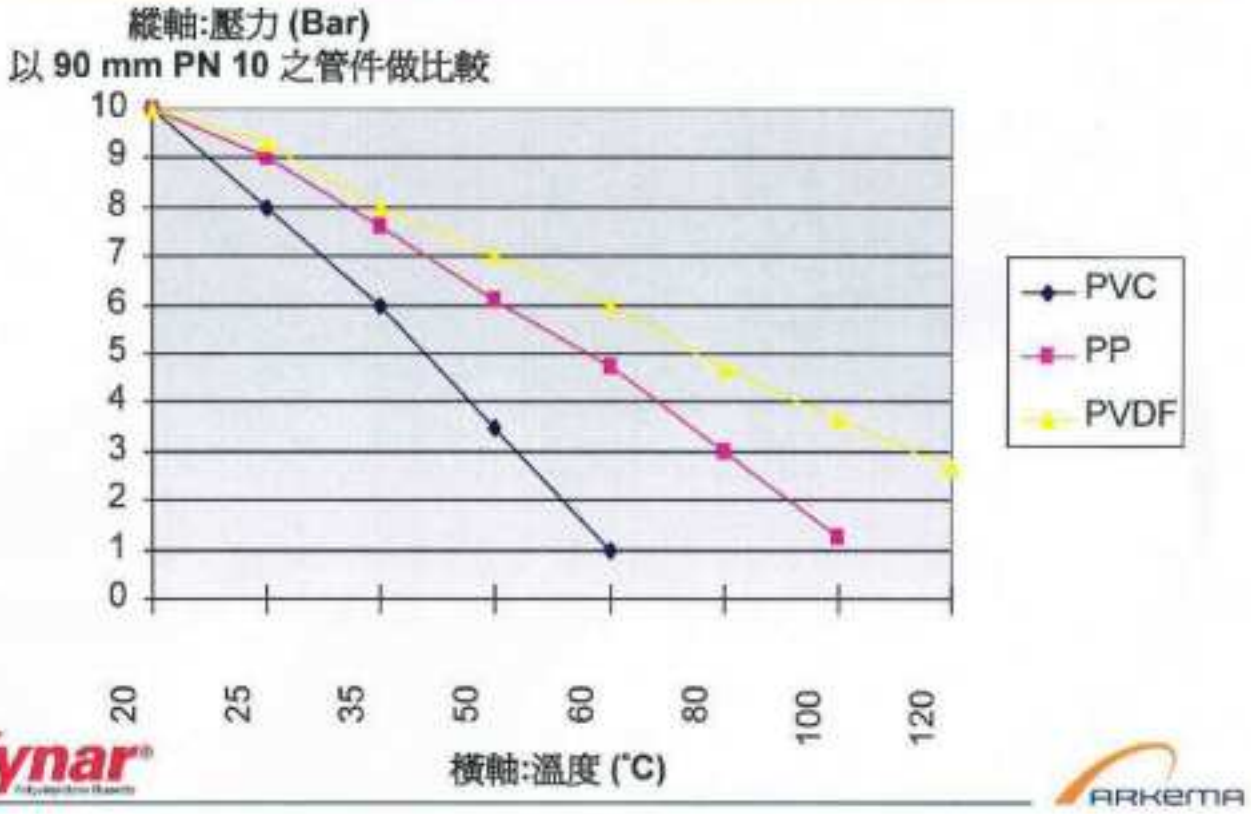
KYNAR® 高熱機械特性



Kynar®

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KYNAR® 具有多項廣泛的認證

KYNAR® PVDF 擁有下列多項的認證

- 食品與藥物管理署 (FDA)：可重複與食品接觸 – CFR 21 § 177.2510 與 CFR 21 § 177.2600
- 美國農業局 (USDA)：可與肉品以及禽鳥類食品接觸
- 3A：多用途使用於乳製食品
- USP VI等級
- NSF 51 (食品設備) 以及 NSF 61 (飲用水)
- NSF 14
- 超純水設備 - Semi F 57
- 低燃性 FM 4910 以及 UL 94-V0

Kynar®

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KYNAR® 可以使用的地方

- **化學產業：**
  - 酸類 (硫酸, 鹽酸), 溶劑類, 過氧化物溶劑
- **製漿造紙業：**
  - 漂白劑, 氯液, 鹼液, 次氯酸
- **製藥工業 (生化, 製藥)**
  - 高純淨度, 蒸氣消毒, 抗臭氧, 表面無沉積物, 無毒害
- **食品工業 (食品)**
  - 不會溢漏, 高純淨度, 表面無沉積酸性物質, 無污點
- **微電子與半導體產業 - « 高純淨度 » 產品**
  - 超高純度純水管, 可儲存在製造中正被酸鹼液漂洗的晶圓片
- **核子工業**
  - 使用壽命長, 對離子性輻射有組抗性, 對氟化物有化學組抗性

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KYNAR® 防腐蝕項目

•使用氯的工業:
在氯或是跟氯相關的化學物品之製造,
二氧化鈦之製造, 環氧樹脂, 光氣 (製造PC).
在程序中使用到氯或是鹵素溶劑的產品
例如製藥, 植物檢疫或漂白.

•使用溴的工業:
在溴或是跟溴相關的化學物品之製造
及運送.在程序中使用到溴的產品
例如製藥, 植物檢疫或防火劑.

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KYNAR® 防腐蝕項目

- 乙醇之製造與其他運用熱礦物酸之產品非常容易與溶劑或是芳香族溶劑混合.

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KYNAR® 防腐蝕項目

錐形交換器
70% 濃硫酸,
120°C

氯液收集管

Kynar 使用於硫酸與硝酸
的排出通道

Kynar

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KYNAR® 多種成型的方式

擠出 押出

射出成型

組裝工藝

Kynar®

ARKEMA

KYNAR® 組裝的技術

機械方式

熔接技術

貼合方式

Courtesy GEORG FISCHER COMPANY

熱塑方式

Kynar®

ARKEMA

KYNAR® 非常廣泛的範圍

- KYNAR® 單一聚合物可運用於押出成型, 射出成型或是熱壓成型 (主要規格有 740, 720, 1000 HD 或 6000 HD)
- KYNAR FLEX® 共聚合物可運用於需要較高之彈性度的產品以及需要抗強鹼性的產品 (主要規格有 2850, 2800, 3120-50)
- 低煙與低燃性的特殊規格 (主要規格有 740-02, 2850-02 以及 2950-05)
- 多種可供分散以及溶解的粉末規格 (主要規格有 301F, 741, 721 以及 2821/2801)

Kynar

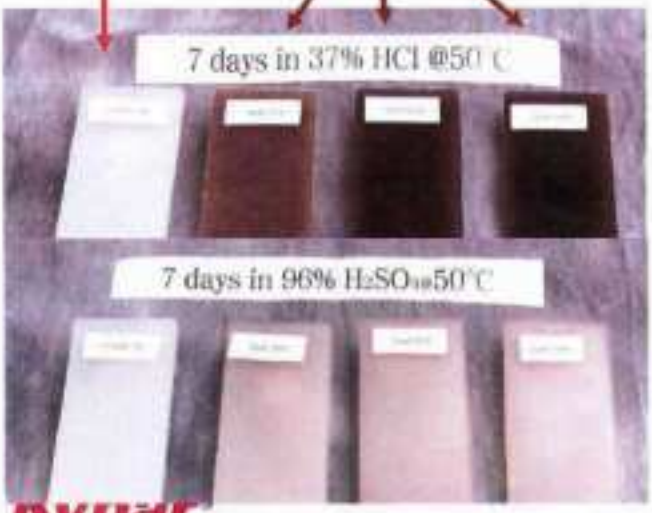
ARKEMA

KYNAR® 與競爭產品之比較

- Colour evolution during service

Chemical immersion

Kynar®　　Solef®



Steam sterilisation

Kynar®　　Solef®

Kynar

ARKEMA

KYNAR® 我們可以提供的訊息

- *我們提供大量的KYNAR® 在化工應用的文獻*
  -> 請參閱我們得網址：www.kynar.com
- *一般應用於化工產業之簡介*
- *成型方式介紹*
- *抗化學性表與比較圖*
- *參考實蹟*

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