



Flame Retardant Polypropylene Product 防火等級之聚丙烯產品
Electrical Insulation Material in Sheet Form 電器與電子產品用之片狀絕緣材料

Formex™

Formex GK™

Statex™

Contents 目錄

- Why do you need insulators 為何需要使用絕緣材料
- Product Series Introduction ITW絕緣材料系列介紹
- Features 特性
- UL Yellow Card & Related Standards UL YELLOW CARD及其相關安全規範標準
- How To Read the Yellow Card 如何閱讀UL YELLOW CARD
- Comparison & Applications 競爭產品比較及應用

Why do you need insulators 為何需要使用絕緣材料

- **I.E.C Standards** (International Electrotechnical Commission) 國際電子協會標準規定
- **Miniaturization Trend** 產品小型化趨勢
- **Product Design** 工程設計需求
- **Different voltage potential of electrical appliance and to prevent from hazard** 應用在不同電壓下之電器電子產品及避免潛在的危險

Product Series Introduction ITW絕緣材料系列介紹

- **FormexTM**
 - It is a retardant grade of polypropylene, extruded into sheet and primarily used for electrical insulation purpose. 它是由一種防火等級之PP材料擠壓成片狀型式，主要用於電器與電子產品上之絕緣需求。
- **Formex GKTM**
 - It is an impact modified electrical insulation material, and specially formulated to improve the score & fold durability. 它是由一種改良型之防火等級PP材料經擠壓成型而成的電子絕緣材料，強化裁痕及摺疊耐久性。
 - Improved impact resistance (Wider fabrication, Cut & Perforation)改良對外部衝擊之抵抗能力（廣範之加工，裁切及穿孔）及較不易因加工不良而破裂。

Introduction Count.

- **StatexTM**
 - It is a surface treatment for static charge dissipation, superior insulating barrier for the applications where static charges are sensitive. 一種經過特殊配方處理以消除表面靜電之材料，尤其在對靜電特別敏感的IC時，它展現優越之消除靜電與絕緣效果。
- **Additional Properties** 其他之特性
 - **Lamination - Aluminum foil, Copper foil, Adhesive** 三明治式貼合製作 - 可將鋁箔, 銅箔或鐵箔和本產品做三明治式貼合, 用以EMI/RFI之隔離及兼具絕緣效果。
 - **Physical barrier only** 做單純之隔離絕緣用。

Features 特性

- Formex™

- 94V-0 grade polypropylene 94V-0防火等級之聚丙烯PP材料
- Very low moisture absorption, approx.0.01% 非常低之吸水特性，近乎0.01%
- High dielectric strength (1720 V/mil @ 18 mil thick) 耐高電壓
- High performance level classes (UL Yellow Card-PLC) 在UL Yellow Card上之特性指數非常高
- High operation temperature 可使用的工作溫度高
- Excellent scoring and die cutting characteristics. 優越之切割及彎折特性
- Excellent adherence for letter printing 優越之文字印刷與不易脫落之特性
- Meet now and future environmental and special legislative issues 符合現今或未來環保法規之規範：
 - **Not contain** any known ozone depletion chemicals like : CFC11~15 or hylon 1211, 1301, 2402
 - 不含危害臭氧層之氟氯碳化物

Features 特性

- **Not contain** polybrominated biphenyls or polybrominated biphenyl oxides (PBBO'S)不含溴化物
- **Not contain** any EVA or EVA additives 不含EVA 或EVA之添加物

• Formex GK™

- Improved impact resistance 改良對外力的衝擊性
- Wider fabrication set-up windows for cut & perforation type scores 對於加工刀模之製作與保養的要求較鬆 故刀模之製作與保養較容易.
- Similar or even better properties as Formex™ with proprietary polypropylene 其於特性近似或優於Formex™系列專利之聚丙烯PP配方產品.

• Statex™

- Proprietary Surface treatment for static charges dissipation 經特殊之配方處理以消除外來靜電之絕緣材料
- Similar performance as Formex™ 特性近似Formex™系列產品

UL Yellow Card & Related Standards

- Insulation material Certificate 絕緣材料證明書
 - All material for insulation propose must be this ID 所有為絕緣用途設計之材料需注意以下規定:
 - UL Yellow Card does not mean meeting the IEC standards, UL CSA VDE.. Safety spec or designers criteria for applications. 絕緣材料本身的UL Yellow Card並不代表該材料可以符合用於各種電器電子產品的IEC標準或UL, CSA, VDE等安規.
 - Whatever, UL issues Yellow Card for the items passed the test only to certify material. It does not confine or approve the applications. Each application should check for its particular requirements. UL發出之UL Yellow Card只是證明該絕緣材料所通過UL的測試項目, 它並非限制或認可該絕緣材料可用於所有電器或電子產品。任何之應用都應依照其專屬的相關安規中有關絕緣材料之規定。

UL Yellow Card & Related Standards

- UL Yellow Card contents 8 important properties UL Yellow Card包含8個重要特性
 - Physics properties 物理特性
 - Thickness, Flammability Rating, Relative Temperature Index (RTI), Hot Wire Ignition (HWI) 厚薄度、防火等級、相對溫度指數、熱線熔化率。
 - Electrical properties 電氣特性
 - High Amperage Ignition (HAI), High Voltage Track Rate (HVTR), Arc Resistance (D495), Comparative Tracking Index (CTI) 高電流熔化率、高電壓沿路徑比率、電弧阻抗及比較路徑指數

Sample

QMFZ2

March 31, 1993

Component – Plastic

FASTEX, DIV OF ILLINOIS TOOL WORKS INC
195 ALGONQUIN RD, DES PLAINES IL 60016

E1216855(N)
(A card)

Mtl Dsg	Col	Min Thk MiM	UL 94 Flame Class	Elec	RTI		H W I	H A I	H V T R	D 4 9 5	C T I
					with Imp	w/o Imp					
Polypropylene (PP), Furnished in the form of sheets,											
Formex – (a) (b) # @	NC	0.20	94VTM-0	100	-	95	5	1	@	@	@
	NC,BK	0.41	94V-0	110	105	100	4	3	@	@	@
	ALL	0.79	94V-0	110	105	110	3	0	@	@	@
	ALL	2.38	94V-0	110	105	110	2	0	@	@	@
	ALL	3.18	94V-0	110	115	120	2	0	0	6	0

(a) - One to three digit suffix indicating nominal thickness in mils.

(b) - May have an additional letter suffix indicating color.

(#) - Subjected to UL 746C Ultra-violet light tests.

(@) - HVTR, D495 and CTI are thickness independent see rating at thickness tested.

Report January 31, 1989
3578630001

Underwriters Laboratories Inc.

(Cont. on A1 Card)
D11/016215445

Standards ...1

- For Information Technology (IT) equipment 資訊
產品之各項相關安規標準
 - Including Electrical Business equipment application 包含電子化辦公設備之應用
- IEC 950, UL 1950, CSA C22.2
 - Minimum creepage distance 最小延面距離

Working Voltage Up to and Including V r.m.s. or d.c.	Operational, basic and supplementary Insulation						
	Pollution degree 1 Material group I, II, IIIa & IIIb	Pollution degree 2 Material group			Pollution degree 3 Material group		
		I	II	IIIa IIIb	I	II	IIIa IIIb
50	Use the appropriate clearance from table III or table IV	0.6	0.9	1.2	1.5	1.7	1.9
100		0.7	1.0	1.4	1.8	2.0	2.2
125		0.8	1.1	1.5	1.9	2.1	2.4
150		0.8	1.1	1.6	2.0	2.2	2.5
200		1.0	1.4	2.0	2.5	2.8	3.2
250		1.3	1.8	2.5	3.2	3.6	4.0
300		1.6	2.2	3.2	4.0	4.5	5.0

Material group I	600 ≤ CTI
Material group II	400 ≤ CTI ≤ 600
Material group IIIa	175 ≤ CTI ≤ 400
Material group IIIb	100 ≤ CTI ≤ 175

Distance through insulation :

- Not required for working less than 50V
- 0.4mm minimum for working voltage exceed 50V at supplementary insulation or reinforced insulation without mechanical stress.

Standards ...2

- Per TUV requirement or Office Equipment Standard (IEC 950) TUV或IEC950對辦公用設備要求標準為:
 - When the applicant submit for TUV test & approval, they should : 當申請人提出樣品給TUV測試及承認時, 必須:
 - Indicate material and **flammability classification** (UL94V-?,) 標明所使用的塑膠材料(含絕緣材料)的製造商, 材料名稱及防火等級.
 - Indicate the **CTI (*Comparative Tracking Index*)** of the insulating materials. 標明此塑膠材料(含絕緣材料)的比較路徑指數, CTI.

Standards ...3

- **Polymeric materials (Electrical insulation materials)**有關化學聚合材料, (電氣絕緣材料)之相關安規規定:
 - Use in electrical equipment applications : UL 746C 用於電器與電子產品: UL 746C
 - Material requirements for internal barrier (electrical insulation) are required to meet various standards or properties of : 此材料作為產品內部隔離用 (即電子絕緣用途)時, 必須符合以下不同之標準或特性:
 - HWI - Hot Wire Ignition 熱線熔化率
 - HAI - High Amperage Arc Ignition 高電流熔化率
 - UL94V- ? - Flammability Classification 防火等級
 - CTI - Comparative Tracking Index 比較路徑指數

Standards ...3

- Others 其他安規規定事項
 - **a.** Dielectric breakdown strength : 5000 Vrms minimum. Higher Values might be needed to perform acceptable in various products. 耐電壓強度：最小 5000Vrms以上，在不同產品時可能會要求更高之數值。
 - **b.** Volume resistivity : $50 * 10^6$ ohm/cm minimum. Higher values might be required in various end products. 絕緣電阻: $50 * 10^6$ ohm/cm以上，在不同產品時, 可能要求更高之數值。
 - **c.** Mold stress relief : No shrinkage, warpage or other distortion to interfere normal operations or reduce electrical spacing. 殘留應力：不會縮收、扭曲或其他變形而影響原有之特性或降低絕緣距離。
 - **d.** Moisture resistance : 2% change maximum in dimension measured before and after 24 hours in water at 23⁰C. This requirement is only for out door equipment application. 吸水率: 在23⁰C室溫時, 將材料浸泡 在水中24小時後取出，其試驗前後尺寸變化率最大不超過 2%，僅應用於室外之產品有此要求。

Standards ...4

e. CTI : 100V minimum for indoor equipments in a relative clean environment. 175V minimum for most outdoor and indoor equipments that may be to moderate contaminated environment. 比較路徑指數：於室內相對乾淨環境中使用的產品，要求為最低要通過100V；於大部份室外或室內設備且為適度污染環境中使用的產品，要求為最低175V.

Application	Properties				
	HWI	HAI	Resistance to ignition Form		Other Criteria
			Flammability	CTI	
Seconds	Arc	Classification			
Use instead of spacings	10	15	94V-0 or 94VTM-0	e.	a. b. c. d.
In Contact with live part	15	30	94V-1 or 94VTM-1	e.	a. b. c. d.
	30	30	94V-2 or 94VTM-2	e.	a. b. c. d.
Used instead of spacings	10	15	94V-0 or 94VTM-0	100	a. b.
In conjunction with an air	15	30	94V-1 or 94VTM-1	100	a. b.
Space	30	30	94V-2 or 94VTM-2	100	a. b.
	30	60	94HB	100	a. b.
Used as a physical barrier only	--	--	94V-0 or 94VTM-0	--	b.
			94V-1 or 94VTM-1		
			94V-2 or 94VTM-2	--	
	30	60	94HB		b.

How to Read the Yellow Card ... HWI

- Hot Wire Ignition 熱線熔化率, Seconds, UL 746A

- A hot wire of 930⁰C is wound a sample test bar and records the time (seconds) until the sampe ignites or burns. 以一條通過930⁰C之高熱線纏繞測試樣品並記錄樣品開始變形或燃燒時的時間，單位為秒。
- UL assign PLC (Performance Level Classes) codes on Yellow Card.因以下所有數值太多且太大，不方便記載，故UL給予一個特性指數以方便記載在UL黃卡上。

HWI, Ignition Time IT (seconds)		Assign PLC On UL Card
120	IT	0
60	IT < 120	1
30	IT < 60	2
15	IT < 30	3
7	IT < 15	4
0	IT < 7	5

HAI

- **High Amperage Arc Ignition**高電流熔化率, Number of Arcs, UL 746A

- This is to measure the average number of arcs to cause the sample to ignite by applying a 240VAC, 32.5A to 2 electrodes at 40 arcs per minute. 這是將240VAC, 32.5A的電流通過二個電極並每分鐘產生40個電弧，來測量樣品在平均多少次電弧下產生變形或燒毀，單位為次數。

HAI, Number of Arc (NA)		Assign PLC On UL Card
120	NA	0
60	NA < 120	1
30	NA < 60	2
15	NA < 30	3
0	NA < 15	4

HVTR

- **High Voltage Tracking Rate** 高電壓沿路徑比率, mm/minute, UL 746

- This is to measure the length of a conductive path generated per minute from two electrodes at 5,200VAC moving toward to cause a leakage during total testing time of 2 minutes. This test result on nominal 3.18mm thick samples can be applied to any other thickness. 這是以二個通過5200VAC的電極相對移動,讓它產生電弧,來測量在待測品上每秒鐘所產生之導電長度,以此檢測二分鐘內之漏電情形。此測試結果是以正常之3.18mm厚之樣品送測,得出數據並適用於其他厚度,單位為 mm / 分.

HVTR, Tracking Rate, TR (mm/min.)		Assign PLC On UL Card	
0	< TR	10	0
10	< TR	25	1
25	< TR	80	2
80	< TR	150	3
150	< TR		4

D495

- High voltage, Low current dry arc resistance, seconds, ASTM **D495** / UL 746A
 - This is to measure how long (seconds) the insulating material can withstand before create a leakage or ignition, burn under two electrodes at high voltage of 12,000V with various frequency, while these two electrodes are reparated by insulating under test.這是測量送測之絕緣材料在多久時間內（秒），經得起二個電極在12000V、不同頻率下衝擊，而不產生漏電、融化或燃燒，單位為秒。
 - This test is insulating material thickness independent also.此測試結果與送測之絕緣材料的厚薄度無關

D495, Average Time of Arc Resistance, TAR (seconds)			Assign PLC On UL Card
420	TAR		0
360	TAR <	420	1
300	TAR <	360	2
240	TAR <	300	3
180	TAR <	240	4
120	TAR <	180	5
60	TAR <	120	6
0	TAR <	60	7

CTI

- **Comparative Tracking Index** 比較路徑指數, Volts, ASTM 3638 / UL 746A

- This is very important parameter for electrical insulating material. The test is to simulate the case that a 1 ampere current develops due to a surface contamination of the plastic insulator in between two conductors with voltage. Again, this is a thickness independent. 這是絕緣材料非常重要的一項參數，這是模擬在送測之絕緣材料於表面受到污染情況下，在不同電壓下通過1安培電流，量測加到多大的電壓會產生漏電，單位為伏特。同樣，此測試結果與絕緣材料厚薄度無關。

CTI, Tracking Index TI (Volts)		Assign PLC On UL Card
600	TI	0
400	TI < 600	1
250	TI < 400	2
175	TI < 250	3
100	TI < 175	4
0	TI < 100	5

Comparison

	Polycarbonate			Polyester	
	Formex	P. C.	PVC	Mylar	Nomex
Flammability	O	O	O	X	O
Temperature	O	O / V	X	X	O
Moisture Absorption	O	V	O	V	X
Score fold	O	V / X	X	X	O
HWI	V	O	O / X	X	O
HAI	O	O	O / X	X	X
CTI	O	V / X	V / X	X	V

Note : O excellent, V good, X poor

Applications ... 1

- Power supply insulation 電源供應器之絕緣
- Power adaptor 電源轉接器之絕緣
- Disc driver insulation 磁碟機之絕緣
- Notebook, personal computer insulation 手提或個人電腦之絕緣
- Bus bar insulation 峇匯流排之絕緣
- Home application insulation 家電產品之絕緣
- Keyboard insulation 鍵盤之絕緣

Application ...2

- TV / Monitor insulation 電視或顯示器之絕緣
- PC board insulation PC板之絕緣
- Panel board insulation 顯示板之絕緣
- Business equipment insulation 商業用設備之絕緣
- Power distribution insulation 電源配電盤, 配電箱之絕緣
- Foil lamination for insulation and EMI/RFI shielding 貼合
金屬箔可兼具隔離EMI或RFI與絕緣用
- Anti-Static protection and insulation 兼具防靜電保護及絕緣用

GE Lexan FR700 UL Yellow Card

QMFZ2

Component – Plastic

GENERAL ELECTRIC COPLASTIC BUSINESS GROUP
STRUCTURED PRODUCTS DEPT.

E61257(R)

ONE PLASTICS AVE PITTSFIELD MA 01201

Mtl Dsg	Min Thk	UL 94 Flame Class	Elec	RTI Mech With Imp	H w/o Imp	H W	H A	H V	D	C
Col <td>MiM <td> <td> <td> <td> <td>I <td>I <td>R <td>5 <td>I </td></td></td></td></td></td></td></td></td></td>	MiM <td> <td> <td> <td> <td>I <td>I <td>R <td>5 <td>I </td></td></td></td></td></td></td></td></td>	<td> <td> <td> <td>I <td>I <td>R <td>5 <td>I </td></td></td></td></td></td></td></td>	<td> <td> <td>I <td>I <td>R <td>5 <td>I </td></td></td></td></td></td></td>	<td> <td>I <td>I <td>R <td>5 <td>I </td></td></td></td></td></td>	<td>I <td>I <td>R <td>5 <td>I </td></td></td></td></td>	I <td>I <td>R <td>5 <td>I </td></td></td></td>	I <td>R <td>5 <td>I </td></td></td>	R <td>5 <td>I </td></td>	5 <td>I </td>	I
Polycarbonate (PC), Designed Lexan, Furnished in the form of sheets,										
FR7, 7+, 700- (a) (b) # @	BK	0.23	94V-0	130	125	130	1	0	-	-
	BK	0.38	94V-0	130	125	130	0	0	-	-
		0.51	94V-0	130	125	130	0	0	-	3
		1.42	94V-0	-	-	-	-	-	-	-
		3.18	94V-0	-	-	-	-	-	-	-

(a) - One to three digit suffix indicating nominal thickness in mils.

(b) - May have an additional letter suffix indicating color.

(#) - Subjected to UL 746C Ultra-violet light tests.

(@) - HVTR, D495 and CTI are thickness independent see rating at thickness tested.

Report January 31, 1989

Underwriters Laboratories Inc.

Only reference, detail please contact GE, Plastics Business Group

Sample *(SUMITOMO BAKELITE)*

QMFZ2

February 14, 1992

Component – Plastic

SUMITOMO BAKELITE CO., LTD.

E41429 (M)

Mtl Dsg	Col	Min Thk MiM	UL 94 Flame Class	Elec	RTI		H W	H A	H V T R	D 4 9 5	C T I
					with Imp	w/o Imp					
Polyvinyl chloride (PVC), designated " Sumilite ", furnished in the form of sheets.											
VSS-HT-200S	WT,NC	0.18	94V-0	50	50	50	-	-	-	-	-
	ALL	1.00	94V-0	50	50	50	-	-	-	-	-
VSS-HT-B0	ALL	0.45	94V-0	50	50	50	-	-	-	-	-
VSS-2602	ALL	0.28	94V-0	50	50	50	-	-	-	-	-
	NC	1.01	94V-0	50	50	50	-	-	-	-	-

(a) - One to three digit suffix indicating nominal thickness in mils.

(b) - May have an additional letter suffix indicating color.

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(@) - HVTR, D495 and CTI are thickness independent see rating at thickness tested.

Report --- ---, ---

Underwriters Laboratories Inc.

Sample (SUMITOMO BAKELITE)

QMFZ2

February 14, 1992

Component – Plastic

SUMITOMO BAKELITE CO., LTD.

E41429 (M)

Mtl Dsg	Col	Min Thk MiM	UL 94 Flame Class	Elec	RTI		H W I	H A I	H V R	D 4 9 5	C T I
					with Imp	w/o Imp					
Polyvinyl chloride (PVC), designated "Sumilite", furnished in the form of cast sheets.											
HT-200	ALL	0.2	94V-0	50	50	50	-	-	-	-	-
		0.38	94V-0	50	50	50	-	2	1	-	-
		0.71	94V-0	50	50	50	-	2	0	-	-
		1.57	94V-0	50	50	50	-	-	0	-	-
ALL	2.97	94V-0	50	50	50	-	-	0	-	4	
HT-200S	ALL	0.25	94V-0	50	50	50	-	-	-	-	-

(a) - One to three digit suffix indicating nominal thickness in mils.

(b) - May have an additional letter suffix indicating color.

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(@) - HVTR, D495 and CTI are thickness independent see rating at thickness tested.

Report --- ---, ---

Underwriters Laboratories Inc.

Sample (TORAY)

QMFZ2

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Component – Plastic

TORAY INDUSTRIES INC FILM DIV

E86511(M)

2 2-CHOME NIHONBASHI-MUROMACHI CHUO-KU, TOKYO 1032, JAPAN

Mtl Dsg	Col	Min Thk MiM	UL 94 Flame Class	Elec	RTI		H W	H A	H V T R	D 4 9 5	C T I
					Mech with Imp	Mech w/o Imp					
Polyvinyl chloride (PVC), designated " Sumilite ", furnished in the form of sheets.											
Lumirror X-10	NC	0.080~ 0.231	94VTM-2	140	130	125	-	-	-	-	-
		0.232	-	140	130	125	-	-	-	-	-
Lumirror Z2	NC	0.025	94VTM-2	105	105	105	-	-	-	-	-
Lumirror Z4	NC	0.025	94VTM-2	105	105	105	-	-	-	-	-
Lumirror S56 or Lumirror S56X	NC	0.050~ 0.138	-	105	105	105	-	-	-	-	-

(a) - One to three digit suffix indicating nominal thickness in mils.

(b) - May have an additional letter suffix indicating color.

(#) - Subjected to UL 746C Ultra-violet light tests.

(@) - HVTR, D495 and CTI are thickness independent see rating at thickness tested.

Report --- ---, ---

Underwriters Laboratories Inc.