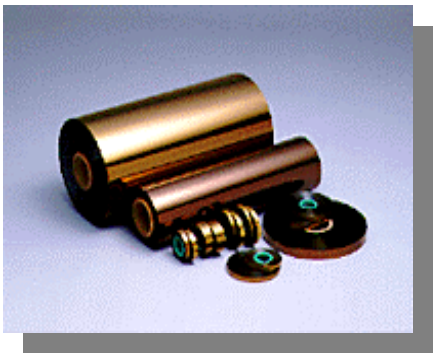
UPILEX®-S



UPILEX-RN	-	High elongation polyimide film
UPILEX-S	-	High temperature polyimide film

UBE's UPILEX-S film offers a unique property mix for many applications like:

Vacuum bagging film
Release film
Separation film
Flexible printed circuits
Heating film
Electrical isolation

Summary

The very good physical, mechanical, electrical and chemical resistance properties are available over a wide temperature range, which has opened a wide application field for this type of film material.
UPILEX offers the best chemical resistance of all polyimide materials. It has no melting point and has the highest UL94 flammability rating VTM-0. The unique properties of UBE's UPILEX-RN and UPILEX-S polyimide films make these films ideal if high process temperatures and tensile strength are required.

UPILEX-S polyimide films are the first choice polyimide film if very high temperatures up to 400°C and higher, depending on the duration are required. Even at very high temperatures, UPILEX-S shows very high dimensional stability and remarkably slight deterioration in its electrical properties. UPILEX-S retains its physical properties even when exposed to chemicals.

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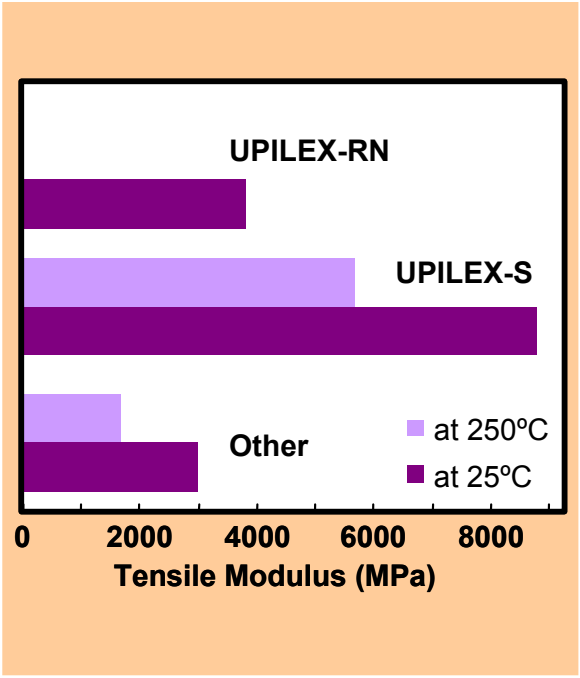
High tensile modulus

UPILEX-RN and -S both have mechanical properties, which are considerably better than competitive products. In particular, UPILEX-S shows outstanding performance, with a tensile strength of 520 MPa, and a tensile modulus of 9121 MPa - more than twice of what was previously available. UPILEX-RN offers excellent elongation of 172% and a tensile strength of 402 MPa. In addition, there is very small degradation of these properties at high temperatures, enabling the use of these materials under extreme temperatures.



Superior dimensional stability

UPILEX-S and -RN have dimensional stability by far outperforming currently available products. Linear expansion, heat shrinkage and hygroscopic expansion are all extremely small.

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Mechanical Properties

UPILEX-S demonstrates outstanding mechanical characteristics through a wide temperature range. UPILEX-S displays high tensile strength and modulus and features outstanding long-term heat resistance. Another advantage of UPILEX-S is its high resistance to hydrolysis, as properties are practically unaffected, even by immersion in boiling water for long periods.

Table-1: Mechanical Properties (Typical Values)

Properties	Unit	UPILEX-25S				UPILEX-75S		Test Method
		- 269°C	-196°C	25°C	300°C	25°C-	200°C	
Tensile Strength (MD)	MPa	735	647	520	294	363	275	ASTMD882
Stress @ 5% Elongation (MD)	MPa	–	–	255	88	206	108	ASTMD882
Elongation (MD)	%	10	15	42	67	50	80	ASTMD882
Tensile Modulus (MD)	MPa	–	–	9121	3727	6963	3825	ASTMD882
Tear Strength-Initiation [Graves] (MD)	N	–	–	226	–	294	–	ASTMD1004
Tear Strength-propagation [Elmendorf] (MD)	N	–	–	3.24	–	4.22	–	ASTMD1922
Folding endurance [MIT]	cycles	–	–	>100000	–	>25000	–	ASTMD2176
Density	g/cm^3	1.47						ASTMD1505
Coefficient of Kinetic Friction (film-to-film)	–	0.4						ASTMD1894
*MD: Machine Direction								

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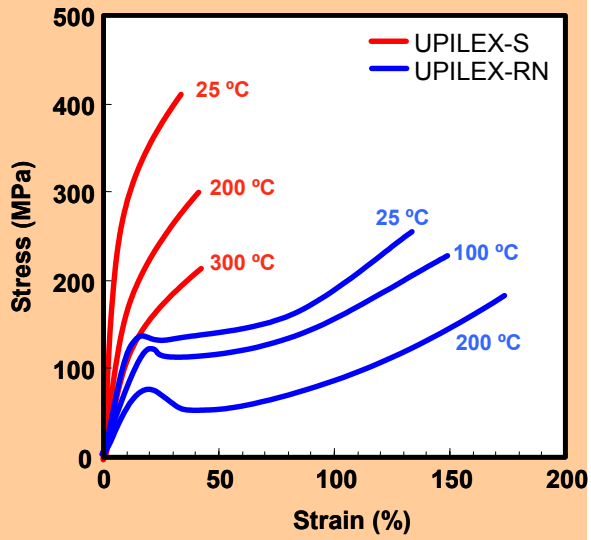
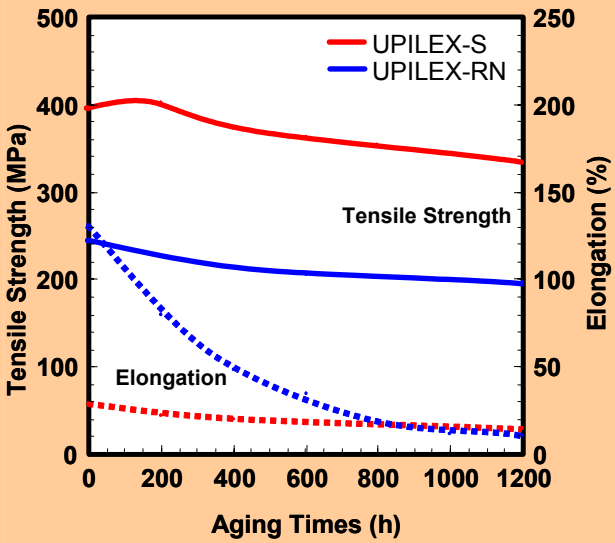
Thermal Properties

UPILEX-S has the highest heat resistance of any plastic film currently available. Its major features include smaller values in both heat shrinkage and thermal linear expansion coefficients and self-extinction (UL94 VTM-0). This makes it ideal for use in FPC and TAB-tape substrates composed of minute circuits.

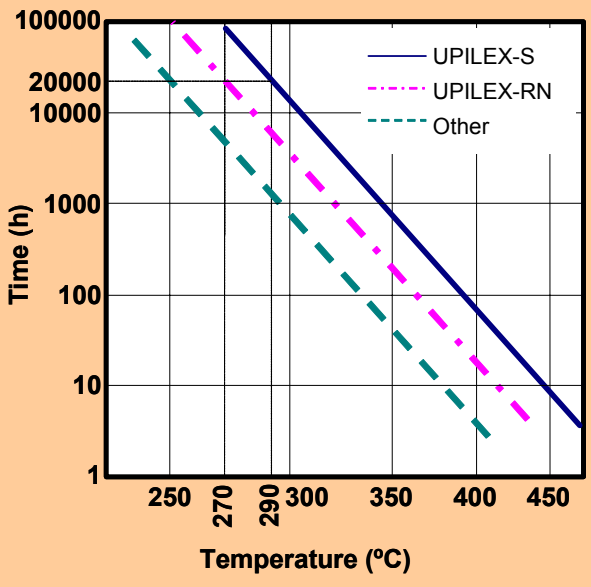
Tensile Strength-Stress Curves



Tensile Strength and Elongation vs. Aging



Temperature to 50% Reduction in Tensile



Thermal Degradation Behavior

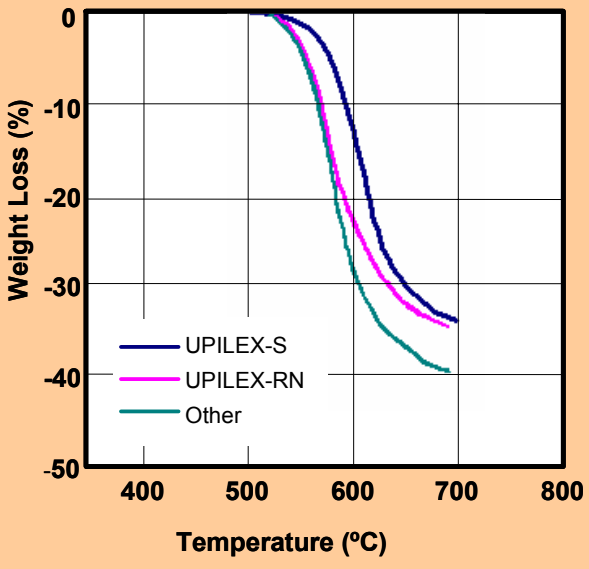


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Table-2: Thermal Properties (Typical Values)			
Properties	UPILEX-25S	UPILEX-75S	Test Conditions (Test Method)
Heat shrinkage (%)	0.1	0.01	200°C, 2Hours JIS C2318
Thermal Coefficient of Linear Expansion between 20–200°C (ppm /°K)	12	20	Values determined by minute linear expansion tester at 5°C/min. temperature increments
Melting Point (°C)	None		
Specific Heat (J/g/°K)	1.13		Differential Scanning Calorimeter
Temperature Index (°C)	290		Heat Treatment: 20,000Hours
Flammability	UL94 VTM-0 (Exceeding 7.5 m)		UL94 File No.48133
Oxygen Index (%)	66		JIS K7201
Thermal Conductivity (W/m/°K)	0.29		Laser Flash Method

Electrical properties

UPILEX-S exhibits excellent electrical characteristics over a wide range of temperatures and frequencies. Even at high temperatures, UPILEX-S shows remarkably slight deterioration in its electrical properties.

Table-3: Electrical Properties (Typical Values)							
Properties	Unit	UPILEX-25S		UPILEX-75S		Test conditions	Test Method
		25°C	200°C	25°C	200°C		
Dielectric Strength	kV	6.8	6.8	11	11	50Hz	ASTM D149
Dielectric Constant	–	3.5	3.3	3.3	3.2	10^3 Hz	ASTM D150
Dissipation Factor	–	0.0013	0.0078	0.0038	0.0056	10^3 Hz	ASTM D150
Volume Resistance	Ω cm	10^{15}	10^{13}	10^{14}	10^{14}	DC100V	ASTM D257
Surface Resistance	Ω	$>10^{17}$	10^{15}	$>10^{16}$	10^{15}	DC100V	ASTM D257

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Chemical-Resistance Properties

UPILEX-S is insoluble in all organic solvents, and is sufficiently resistant to virtually any chemicals, including inorganic acid and alkali solution etc. UPILEX-S retains its physical properties and superior dimensional stability even when exposed to chemicals.

Table-4-1: Chemical Properties: water absorption and gas permeability (Typical Values)

Properties		UPILEX -25S	Test Conditions	Test Method
Water Absorption		1.4%	Immersion in H_2O @23°C, 24h	ASTM D570
		0.8%	Equilibrium at 60%RH, 50°C	
Gas Permeability	Water Vapor	1.7g/m^2	At 38°C, 90%RH for 24 h	ASTM E96
	Oxygen	0.8ml/m^2	At 30°C, 1 bar for 24 h	ASTM D1434
	Carbon Dioxide	1.2ml/m^2		

Table-4-2: Chemical Resistant Properties of UPILEX-25S (Typical Values, Unit %)

Resistance to		Strength Retained	Elongation Retained	Modulus Retained	Test Conditions	Test Method
10% NaOH		80	60	95	Immersion @ 25°C for 5 days	ASTM D882
Glatial Acetic Acid CH_3COOH		100	95	100	Immersion @ 110°C for 5 wks	
H_2O	PH = 1.0	95	85	100	Immersion @ 100°C for 2 wks	
	PH = 4.2	95	85	100	Immersion @ 100°C for 2 wks	
	PH = 8.9	95	85	100	Immersion @ 100°C for 2 wks	
	PH = 10.0	95	85	100	Immersion @ 100°C for 4 days	

Table-4.3: Dimensional Stability: Immersed in Chemicals of UPILEX-25S (Typical Values, Unit: %)

Chemicals	MD*	TD*	Immersion Conditions
Ferric Chloride (37%)	- 0.01	+0.01	at room Temperature for 10 minutes
Cupric Chloride (37%)	+0.01	- 0.01	at room Temperature for 10 minutes
5% Sodium Hydroxide	- 0.02	+0.03	at 60°C for 30 minutes
Isopropanol	- 0.00	+0.01	at room Temperature for 10 minutes
Methyl Ethyl Ketone	- 0.01	- 0.00	at room Temperature for 10 minutes
Methylene Chloride/Trichloroethane (Mixed)	- 0.00	+0.00	at room Temperature for 10 minutes
2N-Hydrochloric Acid	- 0.00	- 0.00	at room Temperature for 10 minutes

MD* = Machine Direction, ***TD**** = Transverse Direction

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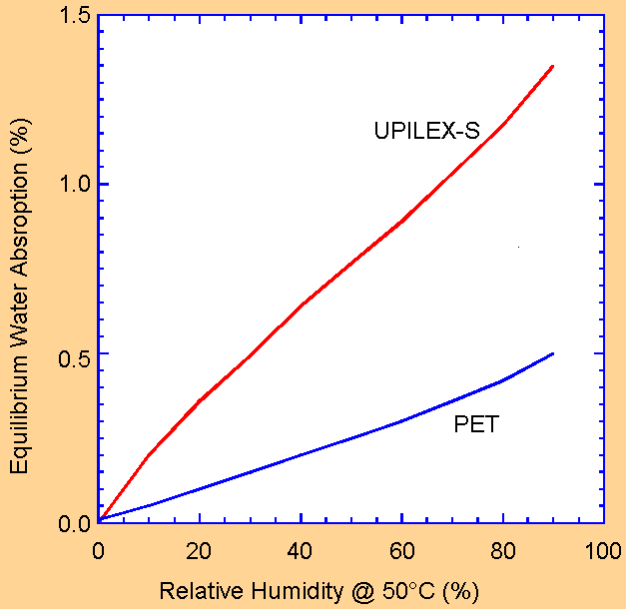
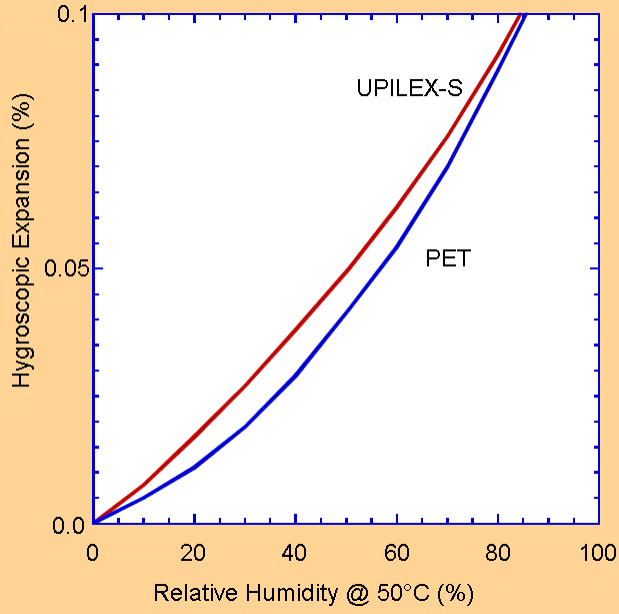
Environmental Resistance

UPILEX-S features low water absorption and hygroscopic expansion. Another advantage of UPILEX-S is its low absorption/desorption speeds and superior weather resistance.

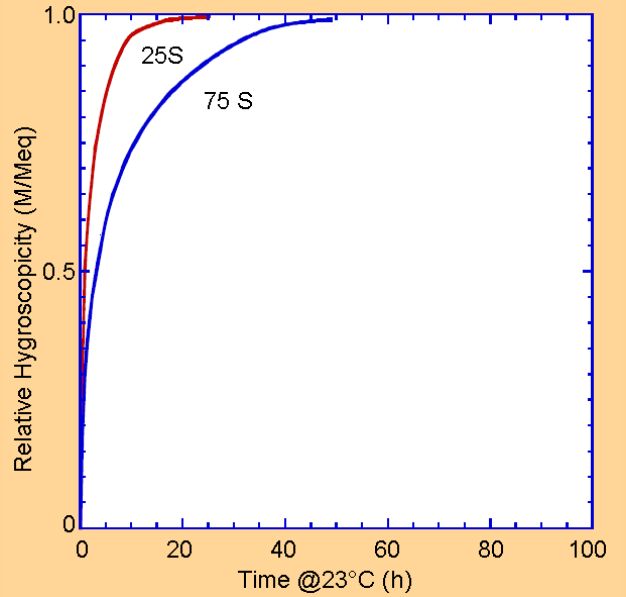
Equilibrium Water Absorption vs. Relative Humidity



Hygroscopic Expansion vs. Relative Humidity



Hygroscopicity



Weather Resistance

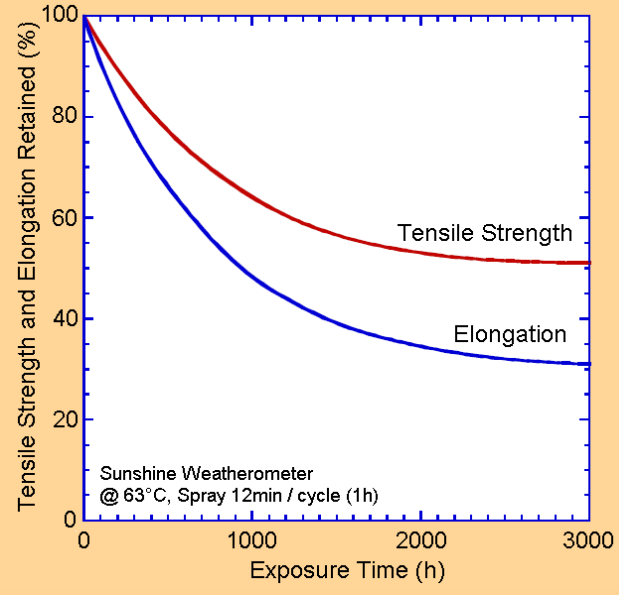


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Table-5: General Properties of Various Heat Resistant Films						
Properties	Unit	UPILEX-S	Conventional Polyimide	Polyester	Polysulfone	Polytetra-fluorethylene
Density	g/cm^3	1.47	1.42	1.38 - 1.41	1.24 - 1.25	2.1 - 2.2
Tensile Strength	MPA	520	173	14 - 25	5.9 - 7.5	1.1 - 3.2
Elongation	%	42	70	60 - 170	60 - 110	100 - 400
Tensile Modulus	Mpa	9120	2961	–	–	–
Tear Strength-Initiation (Graves)	N/mm	226	197	177 - 530	39	–
Tear Strength-Propagation	N/mm	3.24	3.14	4.90 – 10.79	3.92– 4.90	3.92
Resistance to Organic Solvents	–	Excellent	Excellent	Excellent	Excellent	Excellent
Resistance to Strong Acids	–	Good	Good	Good	Excellent	Excellent
Resistance to Strong Alkalis	–	Good	Inferior	Good	Excellent	Excellent
Dielectric Constant	–	3.5	3.5	3.2	3.1	2.1
Dissipation Factor	–	0.0013	0.003	0.005	0.0008	0.0002

Available grades of UPILEX-S

Table-6: UPILEX-S Grades and Area Factors				
Type	Grade	Thickness (µm)	Width (mm)	Area Factor (m^2/kg)
UPILEX-	12.5 SN	12.5	508 / 1016	54.4
	25 S	25	508 / 1016	27.2
	50 S	50	508 / 1016	13.6
	75 S	75	508 / 1016	9.1
	125 S	125	508 / 1016	5.4

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