New Polyimide Film, Kapton® TN

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Abstract

A novel all-aromatic polyimide film named Kapton® TN is developed as a next generation substrate for flexible printed circuits and integrated circuit applications in wireless, digital and computer markets.. It has superior dimensional stability for advanced flexible printed circuits to introduce an asymmetric species in the main structure.

Key words: Kapton®, Polyimide film, Dimensional stability,

1. Introduction

Since 1960s, E.I. duPont and DuPont-Toray Co., Ltd. have been developed various types of Kapton® to meet customers requirement. The attached table I is the evolution of Kapton development[1].

Table I Kapton® Product Evolution

Year	Industry Needs	Product
1965	General Purose	H
1970	Motor/Magnet Wire	F
1974	Low Shrinkage-FPC	V
1984	Improved film handling	HN(H)/VN(V)
1988	Thermal management	MT
1988	Low light transmission	CB
1988	Electrically conductive	XC
1990	Match CTE of Cu	EN
1992	Voice coils	MTB
1993	PI sheet adhesive	KJ
1994	Corona resistant	CR
1995	Formability	JP
2001	New formability for reflector	SKJ

Kapton® H film has been established and proven in various markets with superior mechanical, electrical and chemical properties between hygroscopic temperature of below 5K and super high heat temperature over 700K.

Kapton® F film is a heat-sealable film that retains the unique balance of properties of Kapton® H over a wide temperature range. This is achieved by combining Kapton® H with DuPont Teflon® FEP fluoropolymer

in a composite structure. Kapton® F imparts heat sealability, provides a moisture barrier and enhances chemical resistance.

Kapton® V film is heat-stabilized Kapton®H film for better dimensional stability. The annealing releases remaining stress on the film and achieves lower heat shrinkage below 0.05% at 200degC.

Kapton® MT and Kapton® MTB films are available for applications where improved thermal conductivity is an important design feature. Kapton® MT provides thermal conductivity that is three times that of standard Kapton®. It has excellent physical properties and dielectric strength suitable for applications in heat-sink insulation for power transistors and power supplies. Kapton® MTB is a black polyimide film with increased thermal conductivity over Kapton® H. The film's thermal radiation properties make it ideal for applications requiring efficient thermal energy transfer, such as loudspeaker voice coils and electrical insulating pads.

Kapton® CB film has black color and opaque feature with the same property as Kapton® H film.

Kapton® XC film is an electrically conductive, black polyimide film. A wide ranges of resistivities are available.

The descendant of Kapton® V is Kapton® EN[2)] for high end flexible circuits and packaging market such as CSP, COF, etc. Its suitable coefficient thermal expansion (CTE) matched with copper and lower moisture uptake enable the type to be de facto standard for metallizing two-layer flexible circuits.

Kapton® KJ is a heat-sealable polyimide film used for high-temperature and high-performance material constructions. It maintains excellent adhesion well above its glass transition temperature.

Kapton® CR polyimide film was developed specifically to withstand the damaging effects of "corona," which can cause ionization and eventual breakdown of an insulation material or system when the voltage stress reaches a critical level. Kapton® CR shows corona resistance of greater than 100,000 hr at 500 V/mil (20 kV/mm) at 50 Hz, and provides twice the thermal conductivity of standard Kapton®. These substantial property improvements open the door to new electrical design possibilities.

Kapton® JP polyimide film provides optimum forming characteristics. It offers higher elongation at elevated temperatures, while maintaining the combination of excellent physical, electrical and mechanical properties inherent in Kapton® H. The polymer properties of Kapton® JP enable drawing deeper parts at lower temperatures in shorter cycle times. After forming, parts exhibit excellent shape retention and minimum shrinkage.

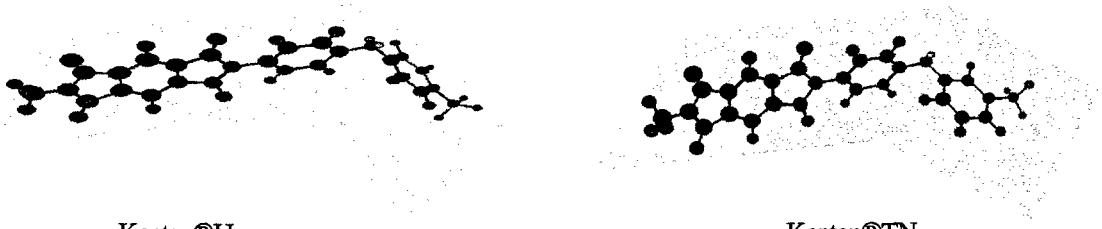
Kapton® SKJ is newly developed type of film for formable application with lower Tg to establish vacuum formation. It enables to achieve deep formation or odd-shaped formation. Its unique feature is designed by the rheology work.[3)]

We have been introducing the above types of Kapton® to meet customers requirements. And current electric market especially flexible printed circuit application requires us to develop new Kapton® to meet fine pitch of copper line distance. The new polyimide film Kapton® TN is developed to meet with the requirement: moderate modulus with suitable coefficient thermal expansion matched with copper.

Discussion

Kapton® polyimide film is synthesized by polymerizing aromatic dianhydrides and aromatic diamines.

Kapton®H has flexible structure without any steric constraint as below chart I. An asymmetric structure in Kapton® TN enables to be superior dimensional stability to Kapton® H. The discussion is if suitable CTE matched with copper and moderate modulus achieve better dimensional stability. The structure comparison is chart I followed by the properties, TableI.



Kapton®H　　Kapton®TN

Chart I: Structure comparison Kapton®H vs. Kapton®TN

Table I Properties

			TN	V	EN	Method
Tensile Strength	MPa	MD	340	311	370	ASTM D-882
		TD	330	276	370	
Elongation	%	MD	75	80	60	ASTM D-882
		TD	80	90	60	
Modulus	GPa	MD	4.71	3.50	5.80	ASTM D-882
		TD	4.53	3.50	5.80	
Dim Stab (at200degC, 2hr)	%	MD	0.03	0.04	0.01	ASTM D-1204
		TD	0.02	0.03	0.01	
MIT	times	MD	>20,000	>20,000	>20,000	JIS P 8115
		TD	>20,000	>20,000	>20,000	
Tear (Grave)	N/20mm	MD	252	250	250	JIS C 2318
		TD	236	250	250	
Tear (Elemendorf)	N/mm	MD	5.9	5.3	7.0	JIS P 8116
		TD	6.0	5.3	7.0	
CTE (50-200degC)	ppm/degC	MD	16.2	25.0	14.7	
		TD	14.8	28.0	16.7	
Water Absorption	%		1.90	2.4	1.7	

Kapton® V is heat stabilized Kapton® H

The properties table I shows that the Kapton® TN has moderate modulus in-between Kapton®H and Kapton®EN. The charts II and III for coefficient thermal expansion (CTE)data for machine direction (MD) and transverse direction (TD) are discussed and the CTE of Kapton® TN follows that of copper for almost all range of the temperature for both MD and TD. This properties will allow the laminator not only to avoid curl but also to achieve higher dimensional stability. Chart IV shows the hydrolytic stability of Kapton® TN has superior to Kapton® H for over 1000 hours. This means that the Kapton® TN maintains better endurance to humid atmosphere. Further study will be conducted.

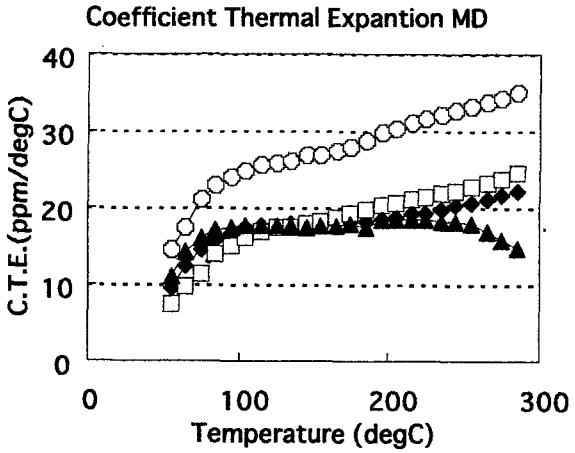


Chart II Coefficient thermal expansion for MD

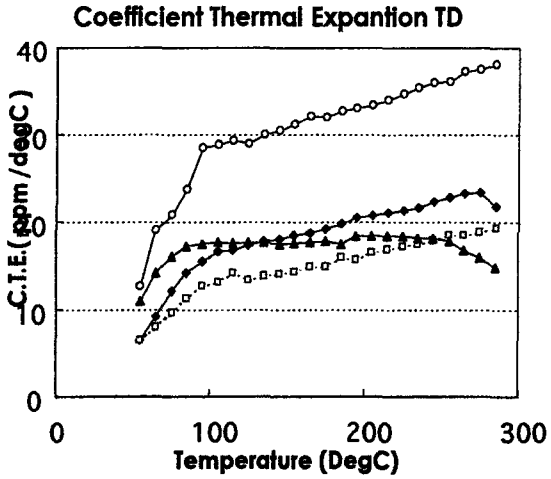
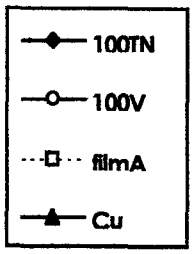


Chart III Coefficient thermal expansion for TD

Legend of chart II and III



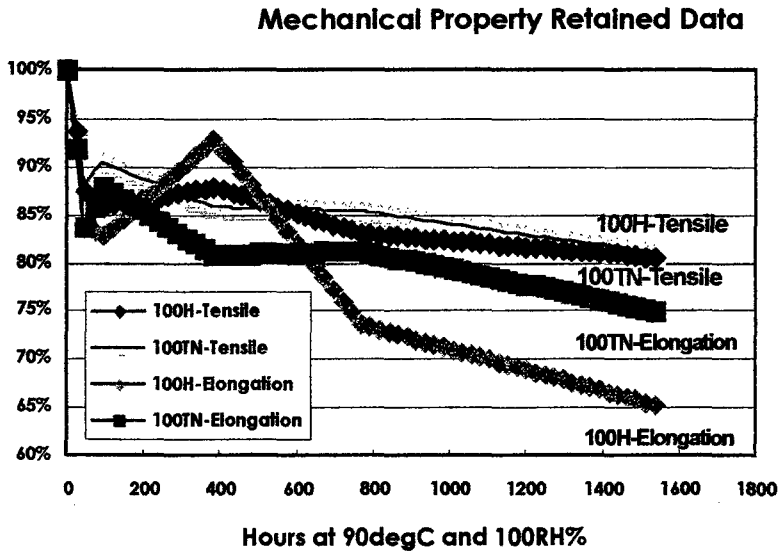


Chart IV: Hydrolytic stability

Reference

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