

Thermoplastic Polyimide reflector

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Abstract:

We have been developing a brand-new thermoplastic polyimide film, Kapton® SKJ for forming applications which

- can draw deeper parts with vacuum forming at 260 to 280°C
- maintains its mechanical stability up to 250°C,
- has very smooth surface with below 0.02 micron meters of Ra,

Kapton® reflector made from Kapton® SKJ is

- ultra lightweight (7 to 40% weight of conventional type).
- not required pre-treatment or base coating.

Figure 1. DMA data of Kapton® SKJ

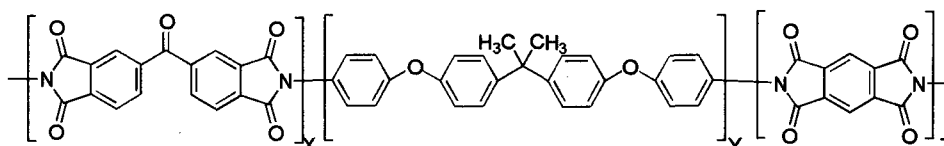
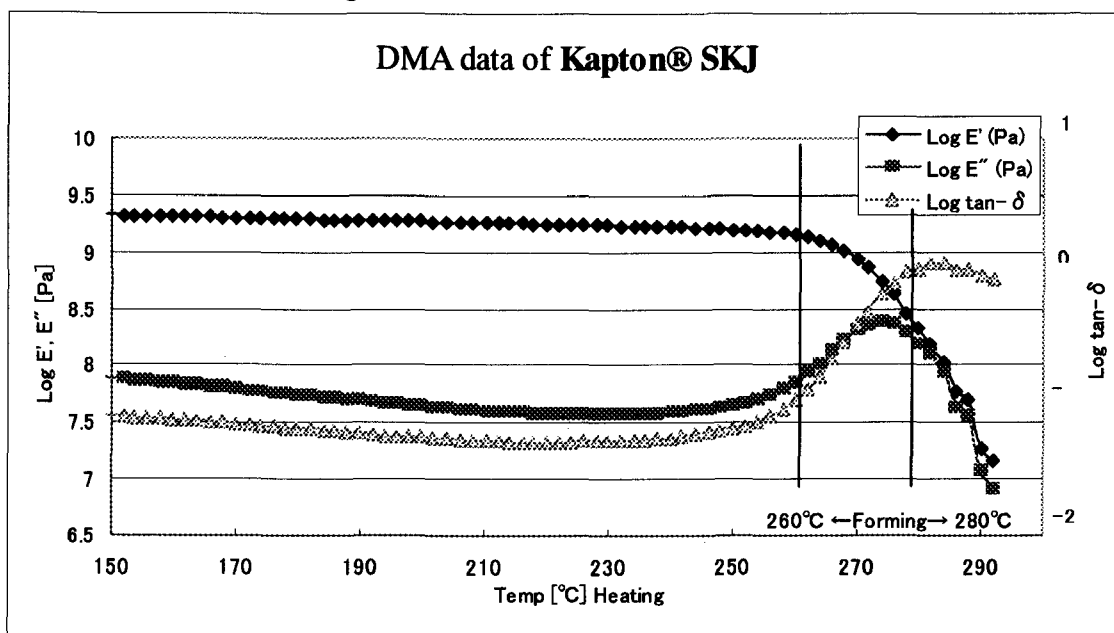


Figure 2. Kapton® SKJ

Introduction:

Conventional lamp reflectors were made with BMC (Bulk molding compound), aluminum or glass. However, all of these materials have many problems. Kapton® reflector has answers for each problems.

The following are key points to resolve the problems:

1. Eco-friendly (1)

Conventional materials required pre-treatment and/or base coating because of their rough surface. These steps exhaust waste and polluted solvent. At the same time, The Kapton® reflector is not required pre-treatment or base coating. Kapton® reflector can achieve zero-Emission on these steps.

2. Eco-friendly (2)

The Kapton® reflector, compared with conventional reflectors, may reduce the disposal waste. This is because the thickness is different: Kapton® reflector is below 0.1mm and conventional ones above 2.0mm. Kapton® reflector has only 0.5% emission to conventional one.

3. Ultra lightweight

Automobile or motorcycle makers require lightweight headlamp reflectors to get excellent gas mileage. However, all of conventional reflectors are very heavy because of their thickness. The Kapton® reflector is below 0.1mm and the weight is 7 to 40% of conventional ones.

4. Better shape accuracy than glass or aluminum.

Kapton® reflectors have better shape accuracy. Glass or aluminum can't draw same accuracy parts with same cost.

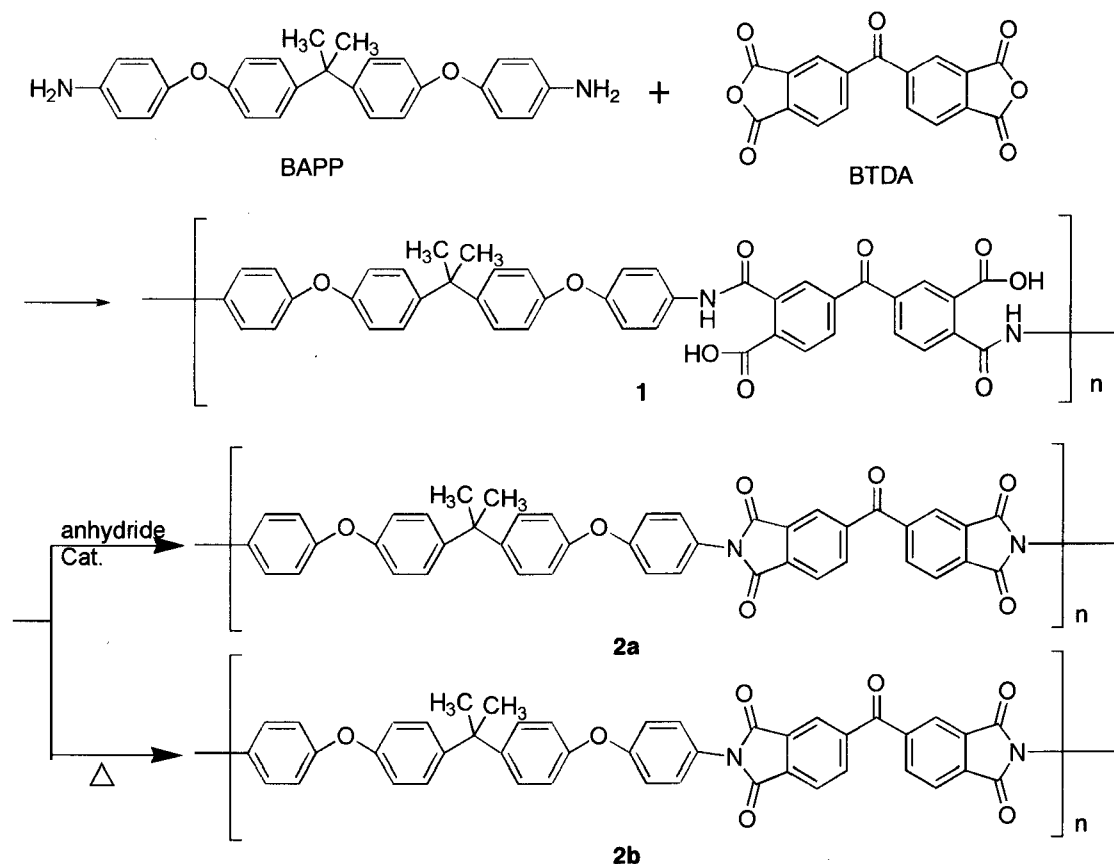
5. Excellent heat durability.

In order to solve above problems, Polyesterimide, Polyphenylenesulfide, Liquidcrystalpolymer and another polymers were tested for the new material of reflectors. However they can't meet either heat durability or easiness of forming. Only thermoplastic polyimide can achieve excellent balance of heat durability and easiness of forming.

We, DuPont group has already developed various kinds of thermoplastic Kapton® for forming application. Kapton® JP was used at first for making the reflectors, however forming time is too long to meet the cost for mass production. Since shorter forming time is required for the forming market, we have started to develop a new thermoplastic polyimide for lamp reflectors.

Result and Discussion

Our screening selected a polyimide that made with BTDA (3,3',4,4'-benzophenone tetracarboxylic dianhydride) and BAPP (2,2-bis[4-(4-aminophenoxy)phenyl]propane) (scheme 1).



Scheme 1. Preparation of BTDA and PAPP polyimide.

Polyimide 2a was imidized by anhydride and catalyst. 2b was imidized only by heating. Tg for 2a was 260°C and it for 2b was 261°C. This result means imidization way was not concerned with Tg. Tg was determined only by chemical structure on this system.

Both 2a and 2b easily drew deeper parts by vacuum forming. However, they couldn't maintain mechanical stability at 240°C.

To increase Tg, various diamines and/or dianhydrides were added to this polyimide 2. Finally Kapton®SKJ was made. Kapton®SKJ has an excellent balance between heat resistance and forming easiness. Property of Kapton®SKJ was summarized on table 1.

Table 1. Property of Kapton®SKJ

	unit	MD	TD	Test Method
Tensile Strength	MPa	117	127	JIS C2318
Elongation	%	88	98	JIS C2318
Tensile Modulus	GPa	2.9	3.0	JIS C2318
Thickness	μm	125		JIS C2318
Smoothness [Ra]	μm	0.02		JPCA BM01 10.2
Water absorption	%	1.3		ASTM D-570
Tg	°C	283		Determined by DMA
Chemical resistance (Aged 5days @25°C, %Elongation change)				
10% NaOH	%	-11	+4	
10% H ₂ SO ₄	%	+4	+6	
10% Acetic Acid	%	+8	+11	
Ethanol	%	-2	+3	
Xylene(80%)	%	10	+3	
Toluene	%	-1	+2	
Mineral oil	%	-4	+8	
Heat resistance (%Elongation change)				
240°C 100h	%	+20		
240°C 200h	%	+21		
-50 →100°C 100cycle	%	+1	-7	
Thermal stability				
1% weight loss [N ₂ /Air]	°C	519/504		Determined by TGA
5% weight loss [N ₂ /Air]	°C	565/555		Determined by TGA
10% weight loss [N ₂ /Air]	°C	580/568		Determined by TGA

It is said that polyimide is damaged by caustic etching. However, Kapton®SKJ has good chemical resistance.

The surface of Kapton®SKJ is very fine (Ra = 0.02μm). Die press forming must transfer print die's rough surface to polyimide surface. However, Kapton® reflector is forming by vacuum forming. Forming with this procedure, Kapton®SKJ can keep its fine surface. So, Kapton® reflector made from Kapton®SKJ isn't required pre-treatment or base coating.

Good heat durability and reflection of Kapton® reflector proved to win 24 Hours Le Mans (Figure 3).



Team	TEAM TAISAN ADVAN
Date	June 2000
Category	LM GT
Position	1st (LM GT)

Figure 3. Kapton® reflector

Summary

We develop a brand-new thermoplastic polyimide Kapton® SKJ which is the best material for reflectors, especially for headlight reflectors.

Reference

- (1) Marketing Bulletin, "Kapton®JP and Kapton®KJ ~ forming applications ~", Du Pont-TORAY Co., Ltd. "Kapton" Marketing and Sales Dept., October 1998.
- (2) *Ibid*, "Head light reflector", Du Pont-TORAY Co., Ltd. "Kapton" Marketing and Sales Dept., October 1998.
- (3) *Ibid*, "Head lamp reflector", Du Pont-TORAY Co., Ltd. "Kapton" Marketing and Sales Dept., November 2000.