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UV-Resistant Laminating Film Aging Test Report

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1. Production Information

Company Name: Yixing Wangzhe Laminating Co., Ltd.

Material Name: UV-Resistant Laminating Film

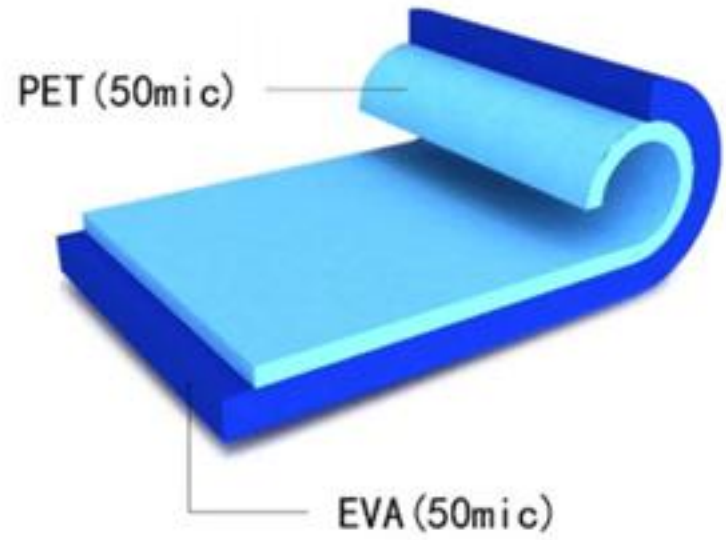
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2. Product Structure Information



Composition: Polyester film + Functionally Modified EVA

The UV-resistant laminating film is a functional outdoor film. It utilizes high-performance polyester film and functionally modified polyolefin material (EVA), offering excellent mechanical properties and UV resistance.

3. UV Accelerated Aging Test

3.1 Test Procedure

According to the international standard ISO 4892-3 (Fluorescent UV Lamp Exposure for Plastics), a UV aging chamber equipped with UVA-340 and UVB-313 lamps was used to simulate UV irradiation at different wavelengths. The irradiance levels were set to 15 kWh/m² for UVA-340 and 7.5 kWh/m² for UVB-313, with a chamber temperature of 35°C. Samples were prepared by laminating both normal and UV-resistant films in "blank laminating" and "laminating with paper" configurations, resulting in four samples. After ensuring cleanliness, the samples were placed at the center of the chamber for uniform UV exposure. During 30 days, samples were taken out every 3 days to measure UV transmittance across wavelengths (200-400 nm) using a UV-Vis spectrophotometer.

3.2 Test Results

UV light (200–400 nm) induces photodegradation, leading to reduced transparency, yellowing, and brittleness. For outdoor applications, UV exposure accelerates the aging of films.

Table 1. UV Transmittance and Blocking Rate at 380 nm for Normal and UV-Resistant Films After Accelerated Aging

Time	UV Transmittance (%)		UV Blocking (%)	
	Normal	UV-resistance	Normal	UV-resistance
0d	73.05	4.56	26.95	95.44
3d	70.44	4.61	29.56	95.39
6d	69.93	4.23	30.07	95.77
9d	64.51	3.99	35.49	96.01
12d	67.96	4.43	32.04	95.57
15d	68.08	3.82	31.92	96.18
18d	64.29	4.14	35.71	95.86
21d	64.41	4.00	35.59	96.00
24d	65.18	3.76	34.82	96.24
27d	64.56	4.39	35.44	95.61
30d	65.26	4.58	34.74	95.42

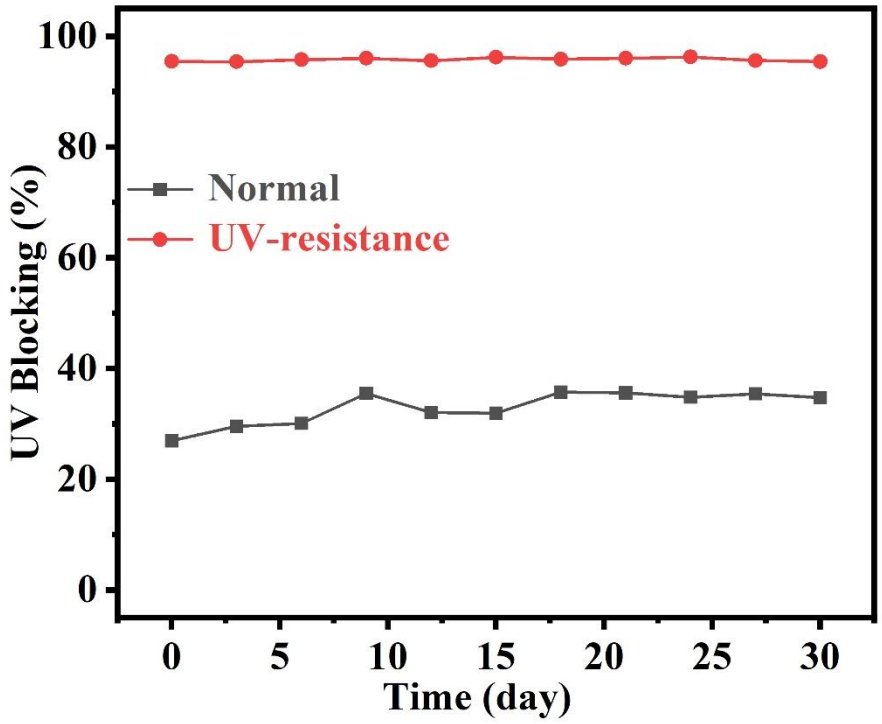


Figure 1. UV Blocking Rates of Normal and UV-Resistant Films Over 30 Days

Table 1. presents the UV transmittance and UV blocking rate (UV blocking rate = 100% - UV transmittance) of the normal laminating film and UV-resistant laminating film after UV aging. Prior to UV aging, the normal film exhibited a blocking rate of only 26.95%, whereas the UV-resistant film achieved a significantly higher blocking rate of 95.44%. Throughout the 30-day UV exposure period, the UV-resistant film consistently maintained a blocking rate above 95%, demonstrating exceptional UV-blocking performance. As illustrated in Figure 1, the UV-resistant film remained minimally affected by UV irradiation, with its blocking rate persistently stable at a high level and showing no notable upward trend. In contrast, the normal film displayed a marked upward trend in blocking rate over time. This indicates that prolonged UV exposure caused the normal film to become increasingly opaque, thereby elevating its blocking rate. Notably, its transmittance decreased from 73.05% (original) to 65.26% after 30 days of exposure.

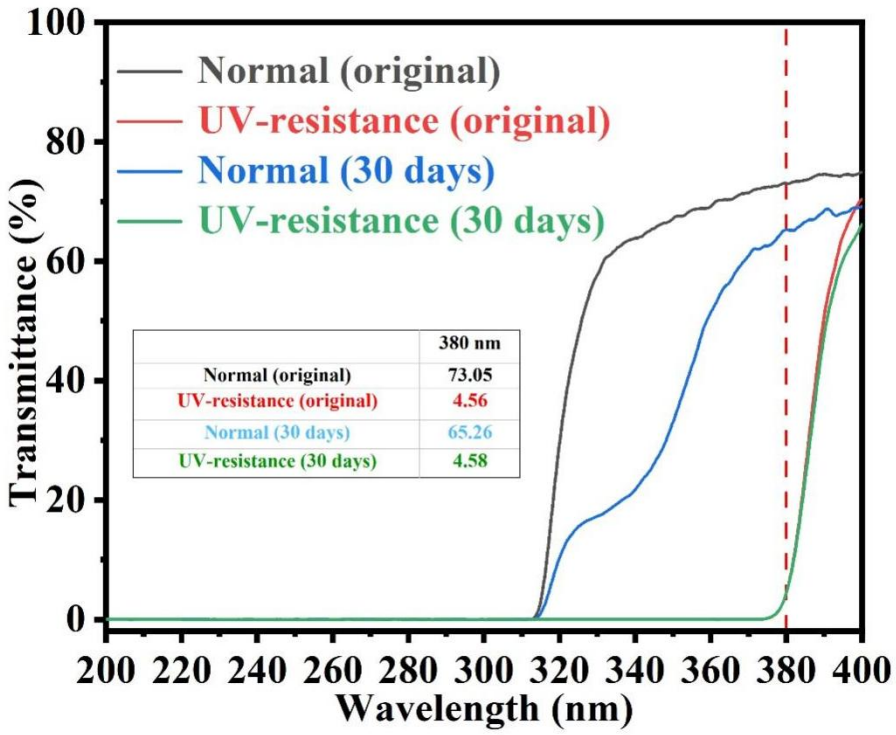


Figure 2. UV Transmittance Curves of Samples Before and After 30 Days of UV Exposure

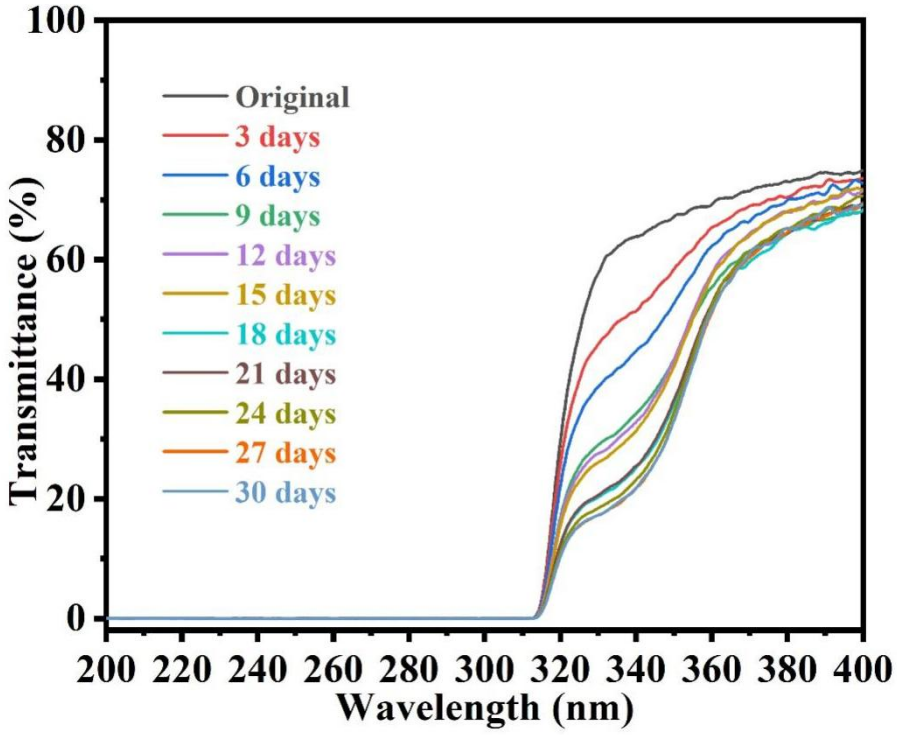


Figure 3. Changes in UV Transmittance Curve of Normal Laminating Film Over 30 Days

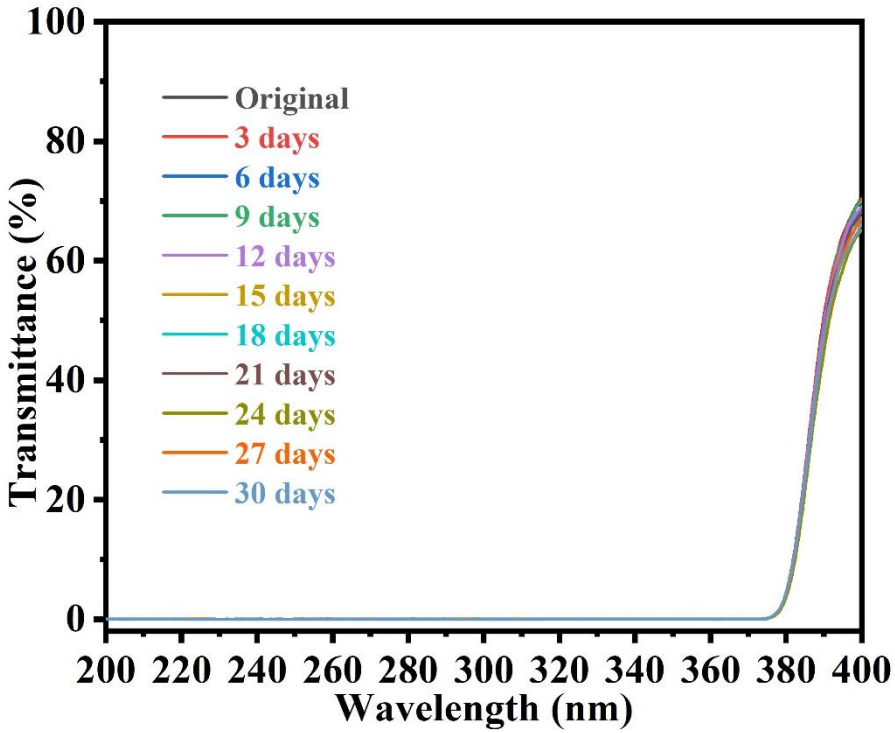


Figure 4. Changes in UV Transmittance Curve of UV-Resistant Laminating Film Over 30 Days

Figure 2 compares the UV transmittance curves of both laminating films before and after 30 days of UV exposure. The normal film's UV transmittance curves show a significant decline, particularly within the 320–360 nm wavelength range, whereas the UV-resistant film's curve remains largely overlapping with its original state. Further analysis of the normal film's transmittance changes over 30 days (Figure 3) reveals a clear downward trend, with the magnitude of reduction increasing over time. This indicates pronounced aging of the normal film under prolonged UV irradiation. In contrast, the UV-resistant film demonstrates stable transmittance even after extended exposure, as shown in Figure 4.

4. Natural Aging Test at 35°C

4.1 Test Procedure

For comparative purposes, we performed a natural aging test without UV irradiation at 35°C. Four samples—prepared as "blank laminating" and "laminating with paper"—were placed in a 35°C forced-air drying oven for 30 days. Every 3 days, the samples were taken out to measure their UV transmittance across the 200-400 nm wavelength

range.

4.2 Test Results

Table 2. UV Transmittance and UV Blocking Rate of Normal and UV-Resistant Laminating Films at **35°C**

Time	UV Transmittance (%)		UV Blocking (%)	
	Normal	UV-resistance	Normal	UV-resistance
0d	71.82	4.37	28.18	95.63
3d	73.41	4.33	26.59	95.67
6d	72.32	4.23	27.68	95.77
9d	74.84	4.46	25.16	95.54
12d	73.43	4.56	26.57	95.44
15d	73.23	4.26	26.77	95.74
18d	70.87	4.22	29.13	95.78
21d	72.01	4.58	27.99	95.42
24d	72.82	4.28	27.18	95.72
27d	69.68	4.48	30.32	95.52
30d	72.94	4.41	27.06	95.59

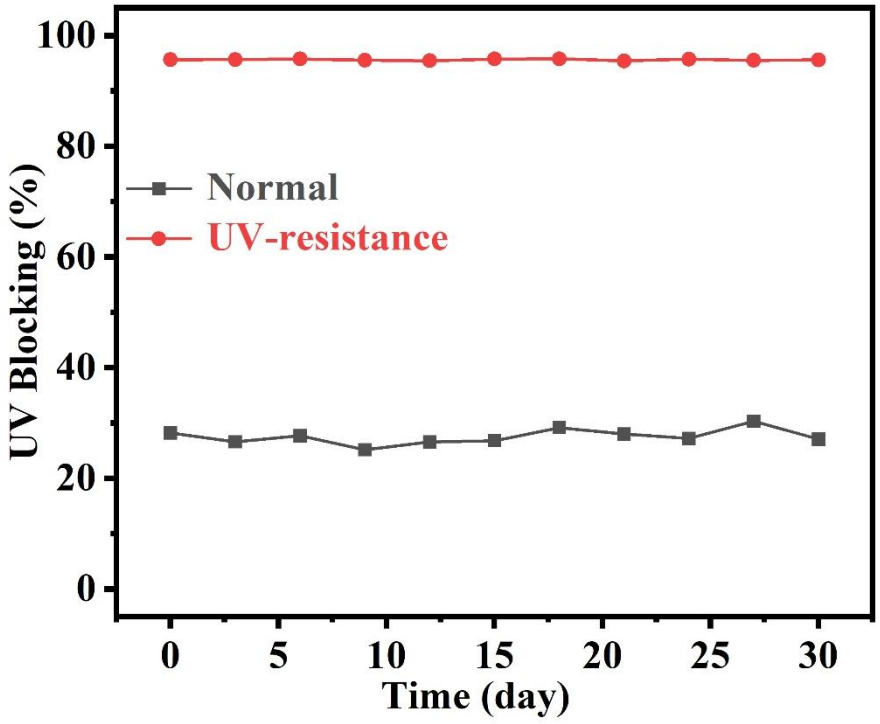


Figure 5: UV Blocking Rate of Both Laminating Films at 35°C Over 30 Days

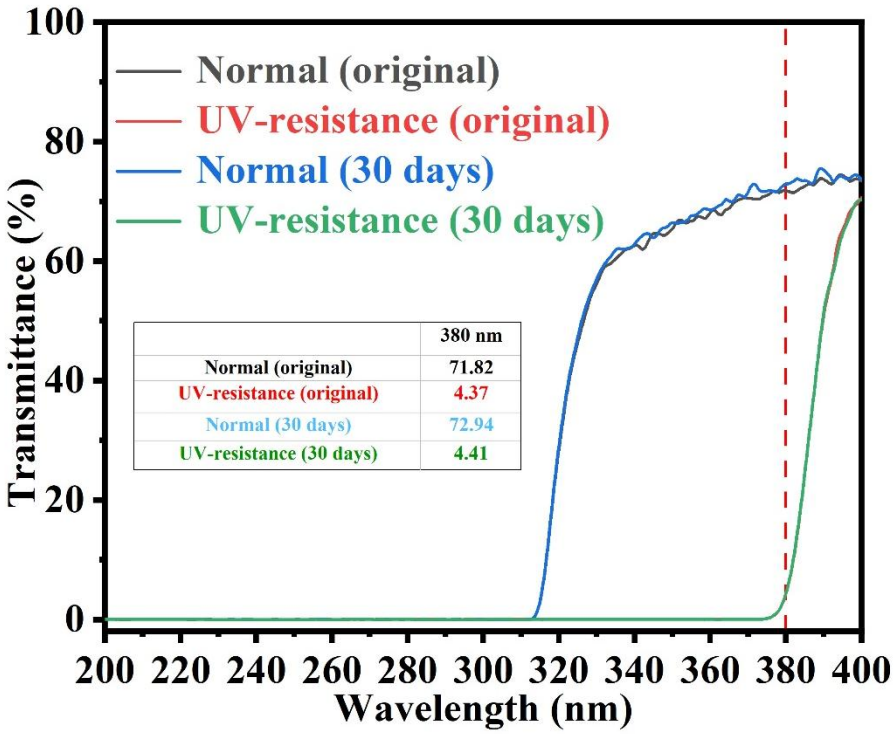


Figure 6. UV Transmittance Curves of Both Laminating Films Before and After 30 Days at 35°C

As shown in Table 2 and Figure 5, under 35°C, both the normal and UV-resistant laminating films exhibited minimal changes in UV transmittance and blocking rates, remaining close to their original levels. Figure 6 further demonstrates that the UV transmittance curves of both films after 30 days at 35°C largely overlap with their original curves. This indicates that aging under thermal conditions (35°C) progresses slowly and has negligible impact on optical transparency. Combined with the UV aging tests, these results confirm that UV irradiation, rather than thermal effects, is the dominant factor driving the aging process of the laminating films.

5. Color Difference Test

5.1 Test Procedure

Color difference testing is a method used to evaluate variations between two colors. The aging of laminating films manifests in color changes, such as yellowing. We employed a colorimeter to measure the color coordinates of the films before and after aging, including: L (Lightness), a (Red-Green axis), b (Yellow-Blue axis). Changes in

these parameters were calculated to assess the films' effectiveness in blocking UV radiation. Additionally, photographs were taken to document the samples' visual changes over 30 days, providing an intuitive representation of color shifts.

Test Samples:

Original state:

Transparent and paper areas of normal and UV-resistant laminating films.

After 30 days of UV aging:

Transparent and paper areas of normal and UV-resistant laminating films.

After 30 days of thermal aging at 35°C:

Transparent and paper areas of normal and UV-resistant laminating films.

5.2 Test Results

Table 3 Color differences of the laminating films before and **after UV aging**

Area	Sample	L	a	b	ΔL	Δa	Δb	ΔE
Transparent	Normal (original)	88.21	2.37	-9.08	-0.21	-0.52	2.04	2.12
	Normal (30 days)	88.00	1.85	-7.04				
	UV-resistance (original)	87.54	0.98	-4.32	-0.36	-0.29	0.82	0.94
	UV-resistance (30 days)	87.18	0.69	-3.50				
Paper	Normal (original)	88.18	1.90	-7.92	-1.83	-1.68	12.77	13.01
	Normal (30 days)	86.36	0.22	4.85				
	UV-resistance (original)	87.60	0.64	-3.79	-0.11	-0.38	2.06	2.10
	UV-resistance (30 days)	87.49	0.26	-1.73				

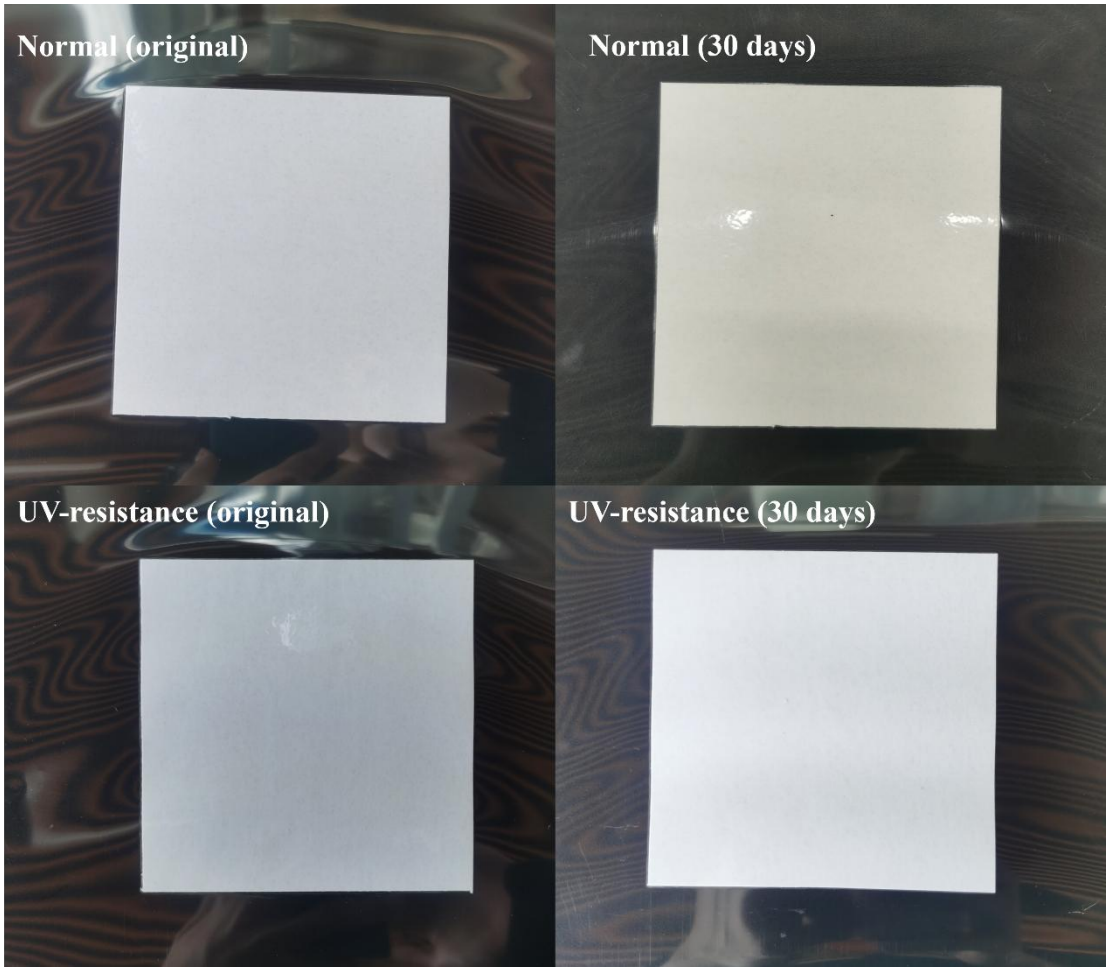


Figure 7. Images of the laminating films before and after UV irradiation

ΔE (Total Color Difference) quantifies the overall color variation, calculated as: $\Delta E=\sqrt{\Delta L^2+\Delta a^2+\Delta b^2}$. A higher ΔE value indicates a greater color difference. In Table 3, both the transparent and white-paper areas of the normal film exhibit significantly larger ΔE values compared to the UV-resistant film. Notably, the white-paper area of the normal film shows a ΔE of 13.01, reflecting drastic color changes after UV aging. In contrast, the UV-resistant film's white-paper area has a much lower ΔE of 2.10, demonstrating its ability to block substantial UV radiation and mitigate aging effects. As shown in Figure 7, the white-paper area of the normal film visibly yellows after UV exposure, while the UV-resistant film retains minimal color change. This further confirms the superior UV-blocking performance of the UV-resistant film.

Table 4 Color differences of the laminating films before and **after aging at 35 ° C**

Area	Sample	L	a	b	ΔL	Δa	Δb	ΔE
Transparent	Normal (original)	88.21	2.37	-9.08	-0.31	-0.15	0.17	0.39
	Normal (30 days)	87.90	2.22	-8.91				
	UV-resistance (original)	87.54	0.98	-4.32	0.07	0.05	-0.17	0.19
	UV-resistance (30 days)	87.61	1.03	-4.49				
Paper	Normal (original)	88.18	1.90	-7.92	-0.25	0.00	0.43	0.50
	Normal (30 days)	87.94	1.90	-7.49				
	UV-resistance (original)	87.60	0.64	-3.79	-0.14	0.14	-0.13	0.24
	UV-resistance (30 days)	87.46	0.78	-3.92				



Figure 8. Images of the laminating films before and after aging at 35 ° C

After aging at 35°C, both the normal and UV-resistant laminating films exhibited minimal color changes, with ΔE values below 0.5 for all tested areas. Comparatively, the UV-resistant film showed even smaller ΔE values, further highlighting its enhanced stability under thermal aging conditions.