

石油暨石化產業科技學術合作

八十八年度期末報告

黑色素之高量生產及在防曬化粧品應用

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一、摘要：

紫外線對皮膚會造成許多嚴重的傷害，包括皮膚紅腫、曬傷、色素沉積、老化、失去彈性及產生皺紋等，甚至會造成皮膚免疫系統受損及增加皮膚癌發生機率。目前防曬化粧品對於紫外線B有保護效果，然而對紫外線A則效果有限。由於黑色素是極佳的紫外線A及B的吸收劑，因此本計畫進行黑色素的研發，以作為防曬化粧品原料。

本計畫利用基因工程技術選殖鏈黴菌之酪胺酸酶基因，經過人工選殖方法篩選高產量之微生物作為宿主，以提高黑色素之表現量，所獲得之黑色素經過純化後添加至防曬基劑中，檢驗其紫外線吸收光譜、防曬係數及對皮膚保護效果的評估。

黑色素在本計畫中主要應用在防曬化粧品，未來希望延續本計畫將黑色素應用在其他抗紫外線產品，例如製成具紫外線隔離效果之隔熱紙；製成具隔離紫外線之太陽眼鏡及加入塑膠製品以防止紫外線引起之塑膠老化現象。

關鍵詞：基因工程；酪胺酸酶；黑色素；防曬化粧品

Keywords : genetic engineering; tyrosinase; melanin; sunscreen

Ultraviolet (UV) can induce severe skin damage, including skin erythema, sunburn, pigmentation, aging, loss of elasticity and wrinkle formation etc. It can also affect skin immune system and increase the risk of skin cancer. The markets of the sunscreen cosmetics are quickly growing. At present, the problem is that most of the sunscreen cosmetics can protect the skin from UVB damage, however, they give limited protection to UVA. Since the melanin is the best UVA and UVB absorber, we plan to express high-level tyrosinase, the key enzyme of melanin synthesis, by using genetic engineering techniques, and produce the commercially valuable materials.

In this project, we clone the tyrosinase gene from *Streptomyces*. And we also screen the transformants for high melanin production microorganisms. After purification, melanin was added to sunscreen formula. The UV absorbance spectrum, sun protection factor and skin protection efficacy of the melanin containing sunscreens were also examined. The key experiments of this project are shown as following.

1. Cloning of tyrosinase gene.
2. Screening of the high melanin production host.
3. Isolation and purification of in vitro synthesized melanin.
4. Evaluation of the efficacy of the melanin containing sunscreens.

High level produced melanin is not only applied to the sunscreen cosmetics, it can be also applied to other anti-UV products. For example, melanin can be added to the car glasses, eye glasses and plastic materials for UV filtration. Because melanin has many applications, it is worth of development and is useful to private or government companies.

二、計畫目標：

1. 人工合成黑色素
2. 評估黑色素在防曬化粧品之利用價值

三、研究背景：

隨著大氣層中臭氧層的減少，紫外線穿越大氣層進入地球表面的量會逐漸增加，人體照射過量紫外線會引起皮膚曬傷紅腫、皮膚癌 (Michielutte 等人, 1996)、皮膚變黑 (Pathak, 1996)、老化 (Goihman-Yahr, 1996 ; Billek, 1996)、皺紋 (Billek, 1996) 及免疫系統受損 (Walker and Young, 1997)等問題。

紫外線依波長長短分為紫外線 A (UVA ,400~320 nm), 紫外線 B (UVB, 320~280 或 290 nm), 紫外線 C (UVC, 280 或 290~230 nm)，其中 UVC 可被大氣層濾掉，所以較不受重視。而 UVB 及 UVA 則依波長不同而有不同傷害。紫外線波長在 UVB 範圍內大約 300 nm 左右可穿透皮膚角質層及表皮層，其能量可引起嚴重的曬傷或紅斑 (Erythema)。而波長大於 300 nm 的紫外線可穿透皮膚的真皮層，因此可刺激黑色素細胞產生黑色素，造成皮膚色澤變化。

黑色素普遍存在於動植物表面，並且具有很多生物功能，包括紫

外線吸收、體溫調節及膚色決定等，由於具有相當廣的紫外線吸收範圍(包含 UVA 及 UVB 波長)，因此相當具有商業價值。黑色素在生物體內是由黑色素細胞所生成，黑色素由酪胺酸氧化而產生，會聚合成不規則之聚合物，存在於 melanosome 胞器內，數量愈多則顏色愈黑，人體表皮、毛囊及網膜均會產生。黑色素生成過程中最關鍵的酵素為酪胺酸酶(圖一)，已證實此基因缺陷會導致黑色素無法生成而成為白子，近年化粧品業所強調的皮膚美白，其有效成分大多具有此酵素抑制作用。

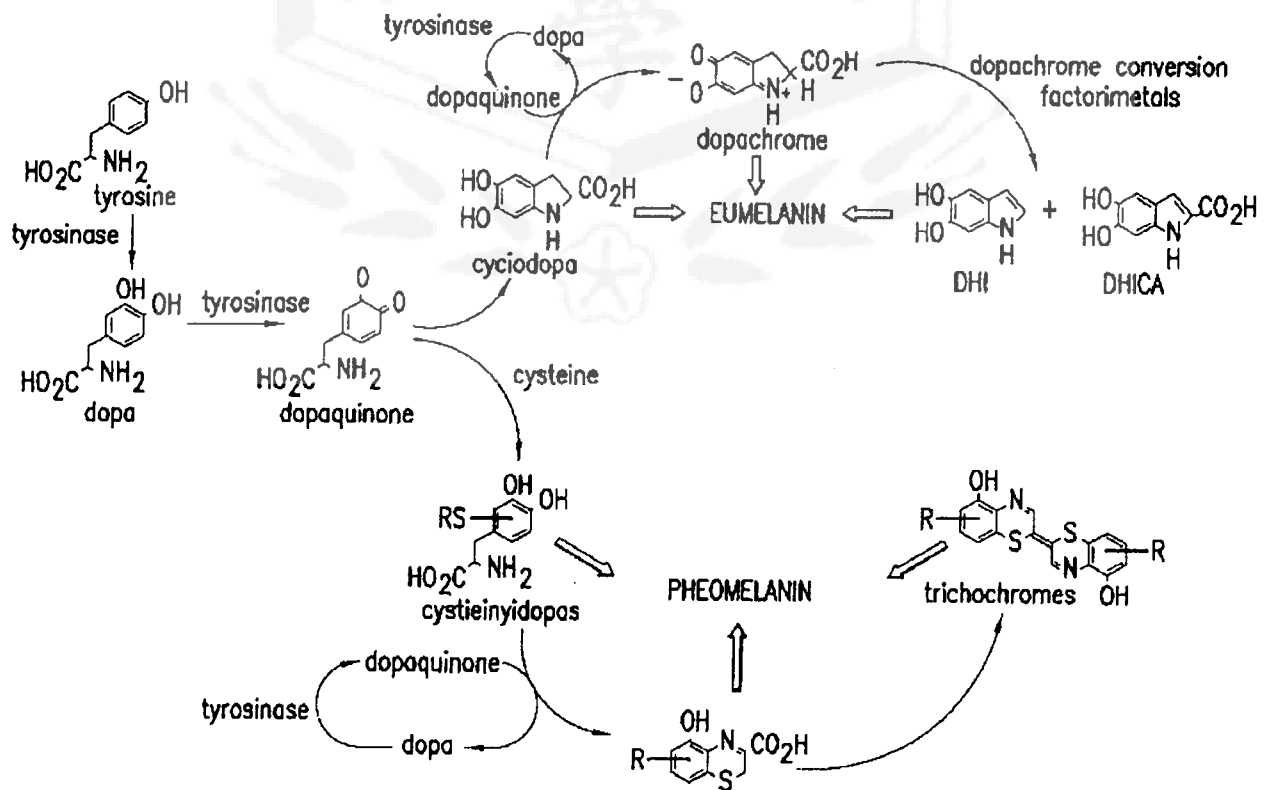


圖 1、Tyrosinase 在黑色素形成過程之角色

酪胺酸酶基因的核酸序列在許多生物如人類、鼠類均已確定，而且可利用 DNA 轉染技術可將酪胺酸酶基因送入白色細胞而使之成為黑色。鏈黴菌具有酪胺酸酶 operon，其中 mel C 為酪胺酸酶基因所在位置，過去陽明大學生化所吳妍華博士實驗室發現 MelC1 蛋白可短暫地與 MelC2 蛋白形成二合體，並可幫助 MelC2 蛋白與銅離子結合及 MelC2 蛋白的分泌，因此 MelC1 蛋白可能是 MelC2 蛋白的 chaperone (Chen 等人，1993)。另外日本 Ikeda 等人(1996)發現鏈黴菌之酪胺酸酶基因上游含有一個開放編譯區(open-reading frame, ORF)，此 ORF 包含 378 base pairs (被命名為 ORF378)可使得被酪胺酸酶基因轉形(transform)鏈黴菌之酪胺酸酶活性提高 110 倍。

目前常用的防曬成份依照作用機轉可分為化學性及物理性兩大類，目前市售常用的化學性防曬成份為 Para-aminobenzoate(PABA)衍生物、Salicylates、Cinnamates、Benzophenone、Anthranilate 等，其主要的作用是吸收紫外線；而物理性防曬常用的成份為 Titanium dioxide (TiO_2), Zinc oxide (ZnO)等，此類成份可同時反射 UVA 及 UVB。傳統上化學性防曬主要吸收能引起曬傷或起紅斑的紫外線(波長 280, 290~320nm)，例如 Salicylates、Cinnamates 及 Para-aminobenzoate (PABA)衍生物等，這些成份目前使用相當普遍。完整的紫外線隔離亦需要 UVA 防曬成份，常使用的成份為 Benzophenone、Anthranilate 等，這些成份可吸收波長大

於 320 nm 的有害紫外線，此類防曬成分的缺點是對皮膚的刺激性較大，因此不適合嬰幼兒及敏感性皮膚使用。物理性防曬成份對皮膚較無刺激性，不過市售防曬化粧品中單純使用物理性防曬成份者仍在少數，因為需要加入的量較多且不溶，因此大多數是與化學性防曬成份混合使用以提高產品的 SPF 值及增加產品對 UVA 的阻隔效果。由於化學性與物理性防曬成分均有缺點，因此本計畫的目的是開發黑色素作為防曬成分。



四、研究方法：

(1). 材料與設備：

- 1.質體: pIJ702; pAK114; pAK114-ORF378
- 2.菌種: *Streptomyces castaneoglobisporus*; *Streptomyces antibioticus*
- 3.紫外線光譜儀: Spectrophotometer
- 4.SPF 測定儀: Labsphere UV1000s
- 8.皮膚色澤計: Minolta Spectrophotometer CM-508i

(2). 研究方法：

A.質體：

依照一般質體的抽取方法分別製備下列質體：

pIJ702 (含 mel C 基因之質體) (Lee 等人, 1986; Ikeda 等人, 1996)

pAK114 (含 mel C 基因之 high copy number 質體) (Ikeda 等人, 1996)

pAK114-ORF378 (含 mel C 基因及 ORF378 之質體) (Ikeda 等人, 1996)

經過純化之質體分別轉形(transformation)至 *Streptomyces castaneoglobisporus*; *Streptomyces antibioticus* 等，欲挑選高產量黑色素生產菌種，將其培養液離心後以紫外線光譜儀測定紫外線吸收光譜，依照其紫外線吸收強弱進行挑選。

B. 酪胺酶蛋白質與 mRNA 分析：

經過挑選的菌種，進行質體確認，同時也進行酪胺酶蛋白質與 mRNA 分析 (Bernan 等人, 1985)。

C. 黑色素的純化及含黑色素防曬化粧品的製備:

由於鏈黴菌生產之黑色素可分泌至菌體外，因此可利用離心方法先將菌體離下，再將上清液通過層析管柱進行純化，黑色素經純化定量後以不同濃度製備成防曬乳液。

D. 紫外線吸收光譜測定:

製備好之防曬產品以防曬係數測定儀測定紫外線吸收光譜，方法如下:

1. 以電動天平秤取 1 公克樣品。
2. 以 10 ml 有機溶劑溶解，如不易溶解則利用超音波震盪處理。
3. 取 1 ml 加入 9 ml 有機溶劑中，連續進行十倍稀釋三次，直到最後濃度為 0.01 % 。
4. 取 2 ml 之最終稀釋液置於紫外線光譜儀測試管中。
5. 紫外線光譜儀先暖機，然後以有機溶劑做背景校正。
6. 使用 250~400 nm 光源進行樣品紫外線吸收光譜測定。

E. SPF 值測定:

利用 *In vitro* SPF 測試儀(型式 UV1000s)測定樣品之 SPF 值，

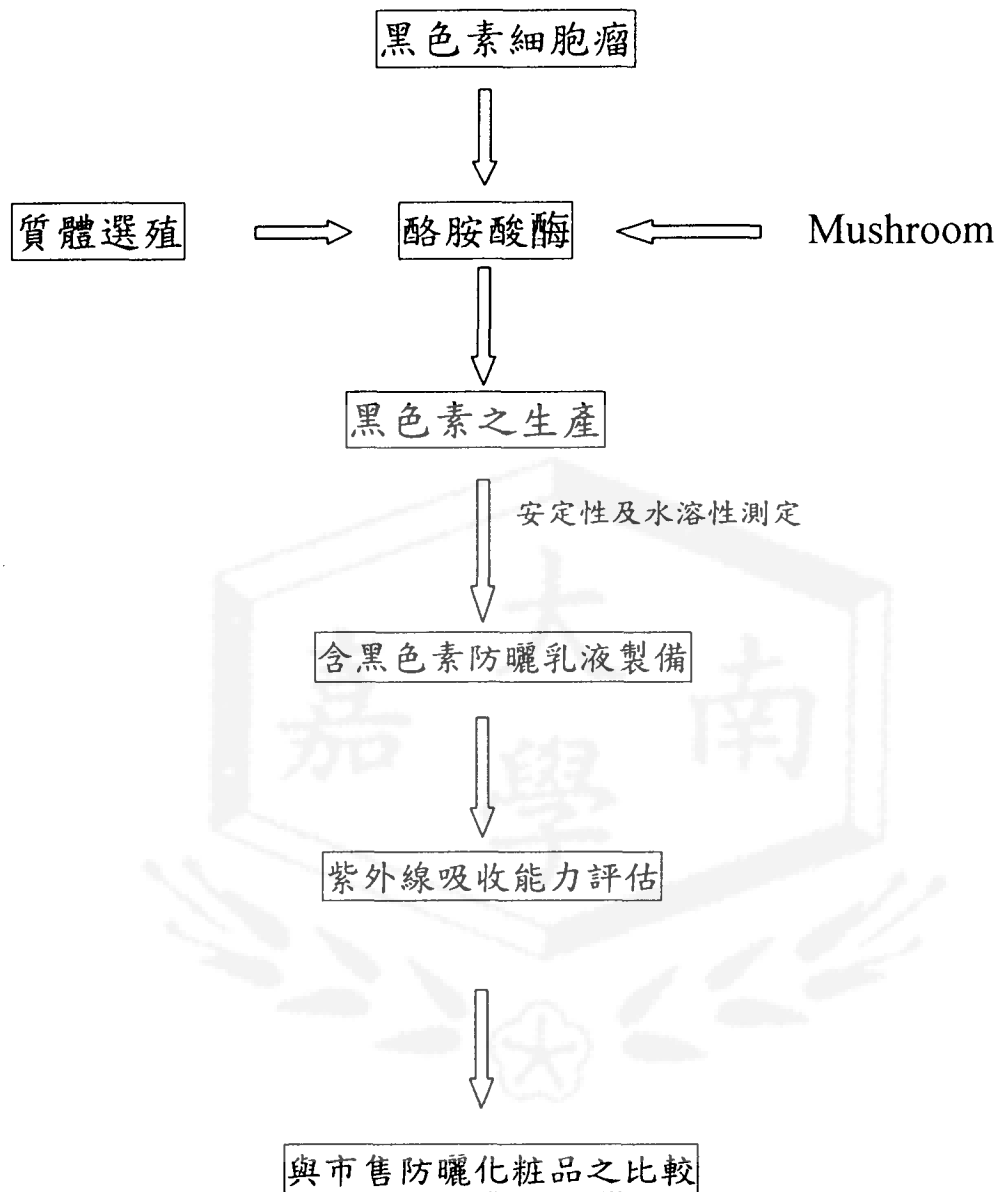
方法依廠商提供方法操作：

1. 取出已貼上 Transpore tape 之石英玻片，稱量 25 mg ($2 \text{ mg} / \text{cm}^2$) 之防曬產品置於 Transpore tape (Diffey and Robson, 1989) 上。
2. 用手指平均塗抹約 10~15 秒，使防曬油平均之分佈於玻璃片上。重覆以上動作，並製作 5 組樣品。
3. 玻片讓其乾燥約 20 分。
4. 重覆二次 baseline 測定，誤差應於 $100 \% \pm 0.5 \%$ 以內。
5. 測定樣品，每一樣品最少測定五次，再求取平均值可得到 SPF 值，將 280~320 nm 與 320~400 nm 之間的吸收值分別積分，再利用 UVA/UVB 星號計算標準或是 UVA 保護寬度星號計算標準進行 UVA 保護效率評估。

F. 皮膚色澤的測定：

首先在手背皮膚上選定不同區域分別塗抹不同黑色素濃度之防曬劑，20 分鐘後比較塗抹防曬劑及未塗抹部位皮膚色澤變化。皮膚色澤變化將利用皮膚色澤計進行檢測，方法是以 Minolta 色澤計測定塗抹防曬劑及未塗抹部位之皮膚的 $L^*a^*b^*$ 值。比較各個測試部位 $L^*a^*b^*$ 值的差異。

五、流程圖：



六、結果：

6.1. 質體 pIJ702 以 Eco RV 作用，可產生單一片段為 5.7 kb；以 Sma I 作用，可產生 3 個片段分別為 4.2, 0.9, 0.6 kb，詳細之基因構造如

圖 2：

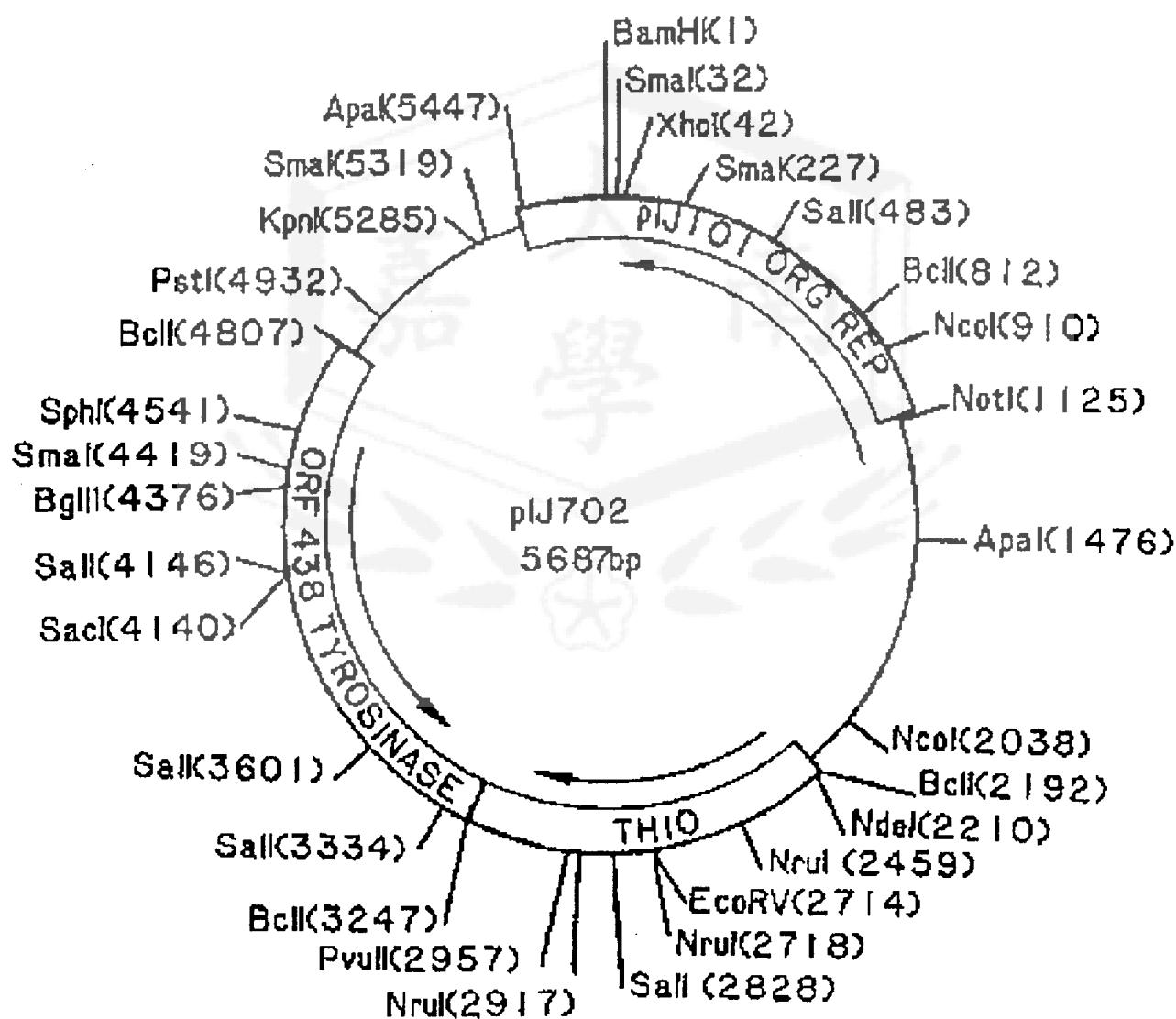


圖 2、質體 pIJ702 之基因圖

6.2 黑色素之生產：

目前由 mushroom tyrosinase (Sigma)及 B16 melanoma cell 取得酪胺酸酶，取 1400 units mushroom tyrosinase 加入 50 ml L-tyrosine (0.1 mg/ml PBS) 中，於 37 °C 放置 4 小時，可獲得黑色素，其紫外線吸收光譜如圖 3-1 所示，主要吸收波峰位在 280 nm 附近，不過其吸收範圍涵蓋 UVB~UVA，經過計算 UVB 之穿透只剩下 6.78 %，UVA 之穿透只剩下 7.76 % (圖 3-1)，此結果顯示人工合成之黑色素亦具有良好之紫外線吸收效果。

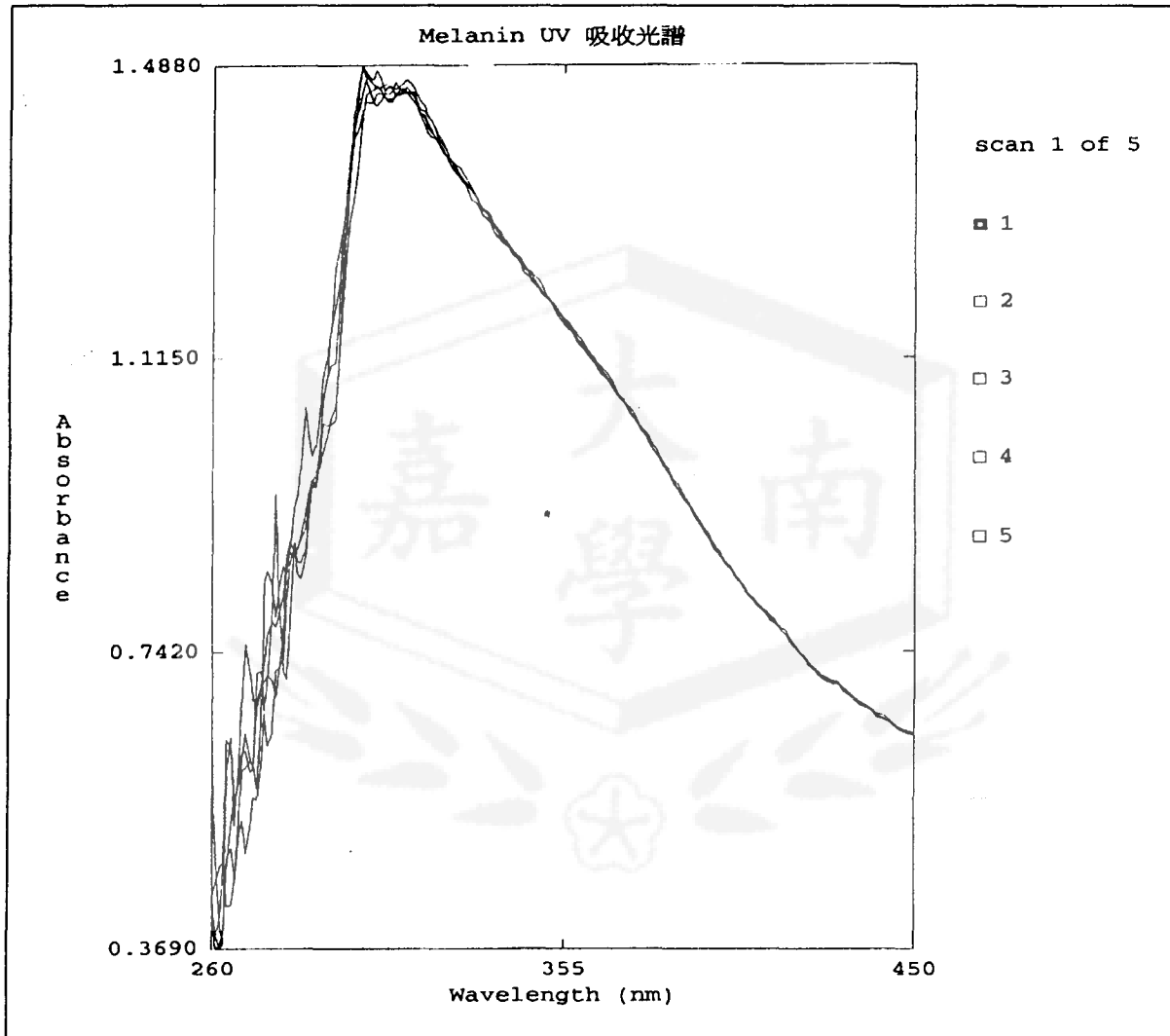


圖 3-1、黑色素之紫外線吸收圖譜

Labsphere Ultraviolet Transmittance Analyzer
SPF Report

Sample: Melanin UV 吸收光譜
 Operator:
 Client:
 Comment: 2d
 Date: 28 Aug 1998
 Time: 11:29 am
 Wavelength Range: 290 - 400 nm

Units:	SPF	T(UVA)	T(UVB)
# of Scans:	5	5	5
Mean:	25.04%	7.76%	6.78%
STD:	0.48%	0.04%	0.47%
COV:	1.90%	0.57%	6.86%
UVA Ratio:	0.82		
Star Category:	****	MAXIMUM	

Scan #	SPF	Critical Wavelength	Scan #	SPF	Critical Wavelength
1	24.99	386 nm	7		
2	25.58	386 nm	8		
3	24.50	386 nm	9		
4	24.67	386 nm	10		
5	25.47	386 nm	11		
6			12		

圖 3-2、黑色素之紫外線吸收能力

為了提高黑色素之生產量，於是嘗試延長反應時間及提高酪胺酸酶濃度(圖 4)。反應時間由 4 小時延長至 24、48、72 小時等(圖 5)。

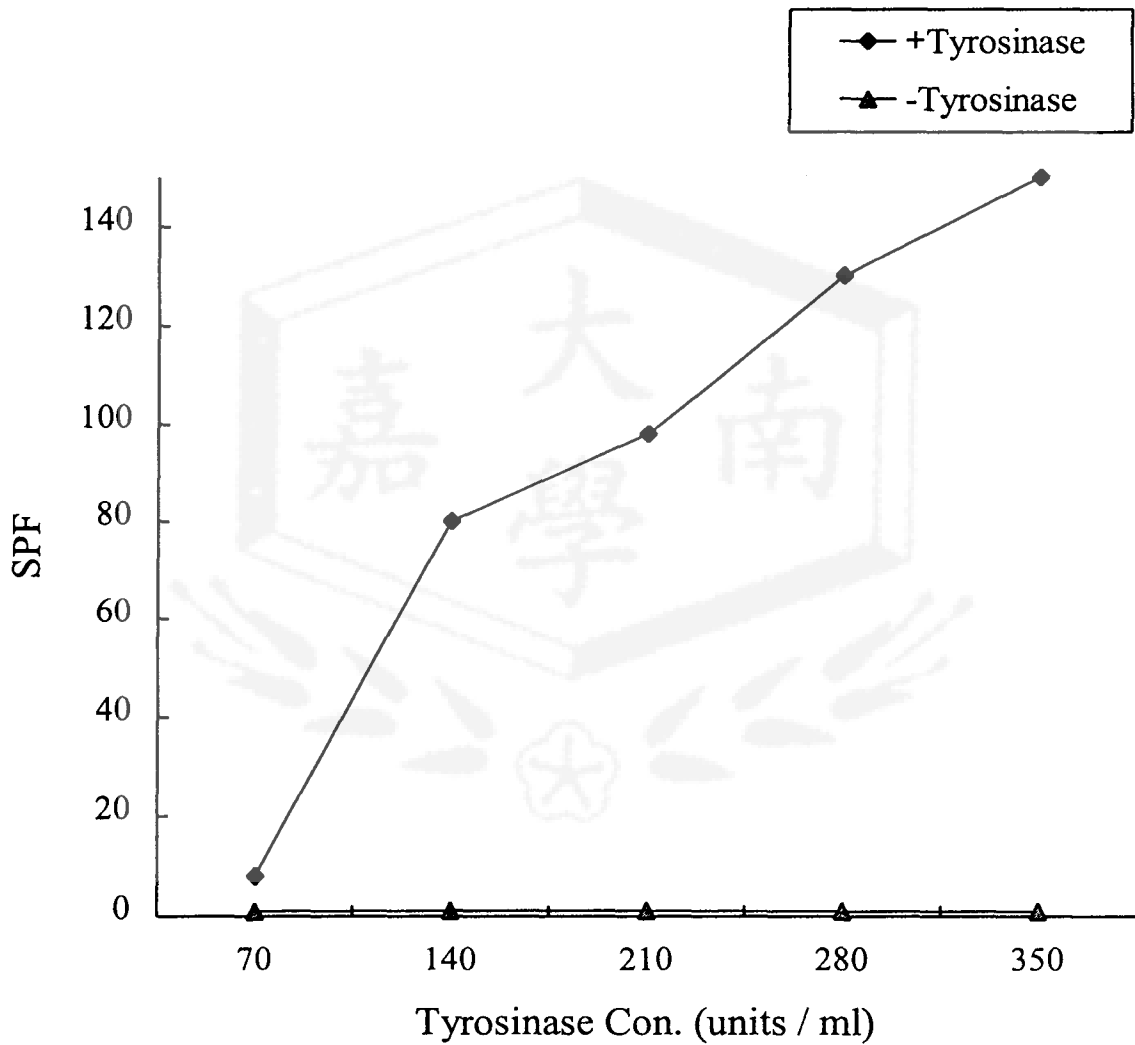


圖4、Tyrosinase 濃度對黑色素產量的影響

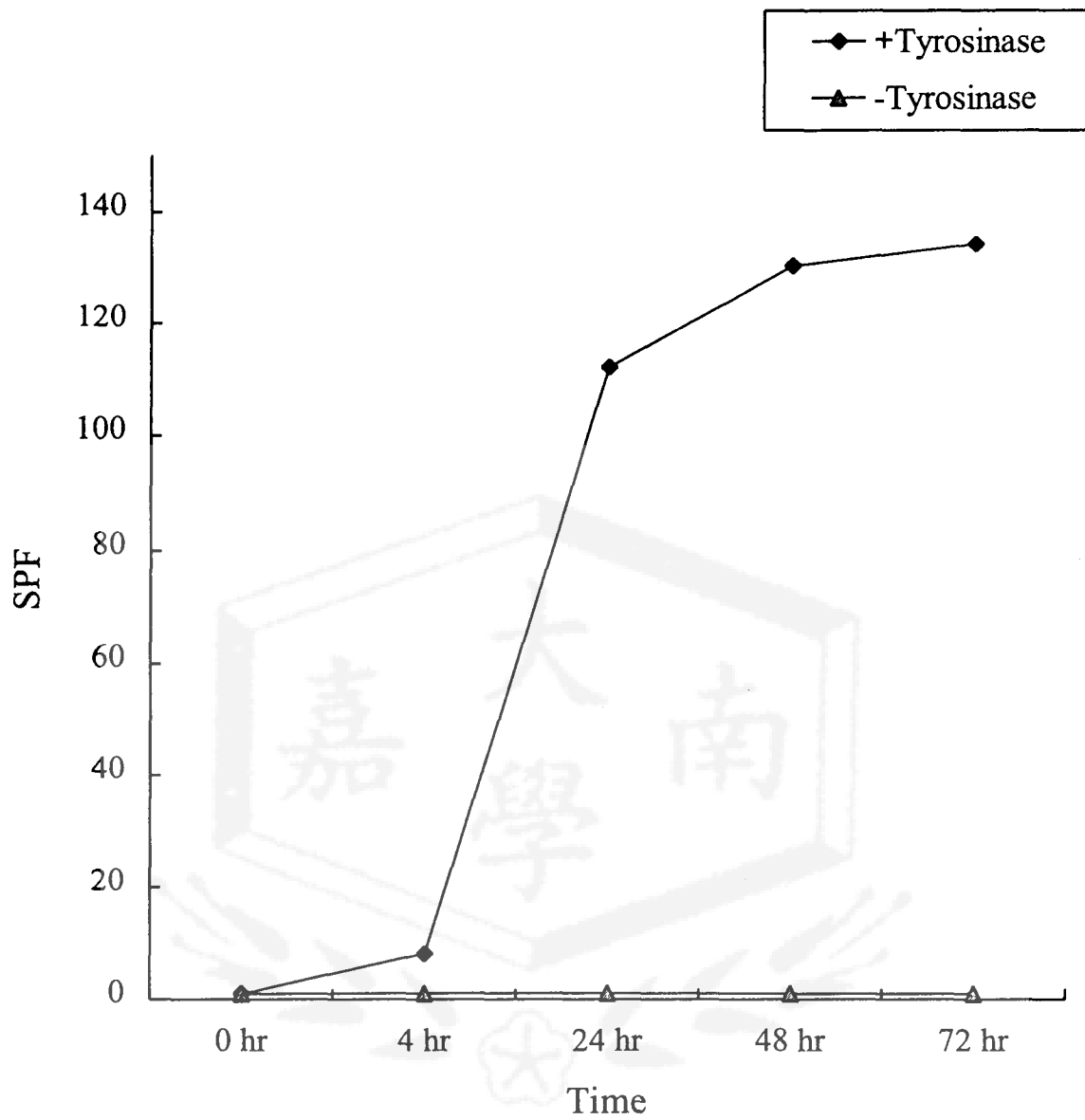


圖5、作用時間對黑色素產量的影響

6.3 黑色素顆粒分析：

黑色素之應用的阻礙之一為顆粒太大以及對水之溶解度太低，為了突破這個限制，我們改變溶液之配方，結果這個方法製造的黑色素具有水溶性，將所生產之黑色素通過 0.45 μm 之過濾膜，過濾前後之黑色素分別測定紫外線吸收光譜，結果顯示 95% 以上之黑色素均能通過 0.45 μm 之過濾膜。



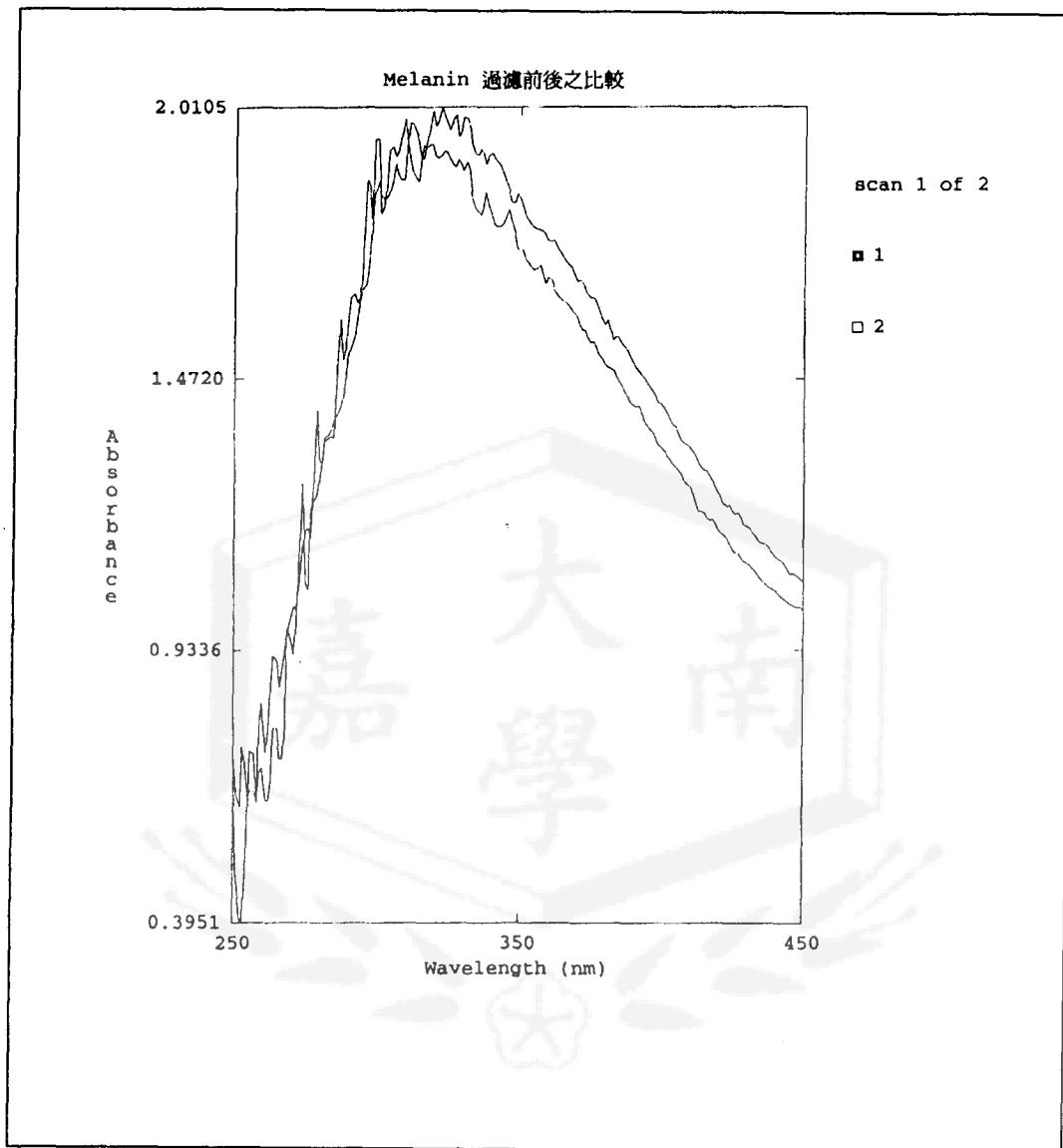


圖 6-1、黑色素過濾前後之比較圖

Labsphere Ultraviolet Transmittance Analyzer
SPF Report

Sample: Melanin 過濾前後之比較
 Operator:
 Client:
 Comment: 7/12 make
 Date: 15 July 1999
 Time: 10:06 am
 Wavelength Range: 290 - 400 nm

Units:	SPF	T(UVA)	T(UVB)
# of Scans:	2	2	2
Mean:	74.68%	2.14%	2.30%
STD:	0.07%	0.29%	0.14%
COV:	0.10%	13.40%	5.88%

Scan #	SPF	Critical Wavelength	Scan #	SPF	Critical Wavelength
1	74.73	387 nm	7		
2	74.63	387 nm	8		
3			9		
4			10		
5			11		
6			12		

圖 6-2、黑色素過濾前後之比較

6.4 黑色素熱安定分析：

由於化粧品乳化之溫度為 80°C ，為了確定黑色素之紫外線吸引能力不會在化粧品製造過程中遭受破壞，因此進行黑色素熱安定分析：加熱時間分別為 0, 5, 10, 15, 20, 25, 30 分鐘，加熱後立刻進行黑色素之紫外線吸收測定，結果顯示，經過加熱黑色素之紫外線各波長吸收並無顯著差異；其 SPF 值亦無明顯變化（圖 7）。

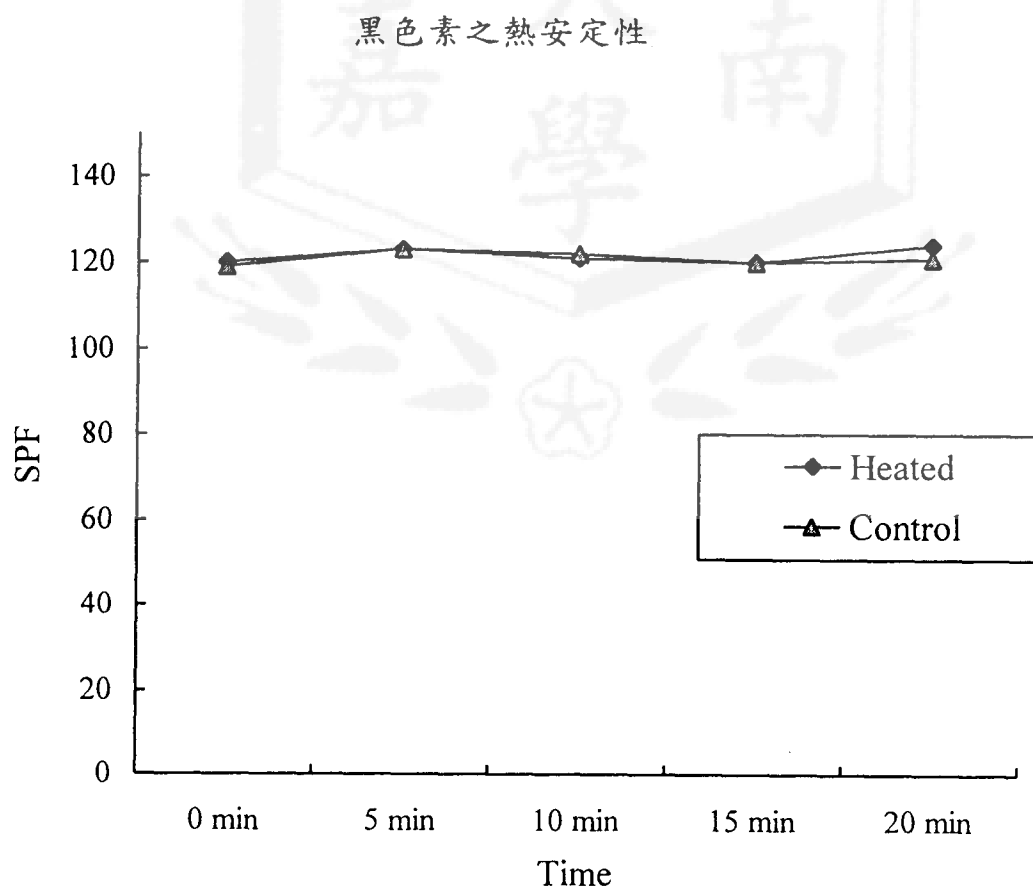


圖 7、黑色素熱穩定試驗

6.5 含黑色素防曬乳液製備：

表 1、黑色素防曬乳液配方

成分 \ 種類		Pasol 0%	Pasol 0% +melanin	Pasol 6% +melanin
A	Kowax K-32	8.5	8.5	8.5
	Liponate SS(stearyl stearate)	2.5	2.5	2.5
	Lipovol MOS 70	8.0	8.0	8.0
	Finsolv TN(cetyl lactate)	1.0	1.0	1.0
	Uniphon P-23(propyl paraben)	0.5	0.5	0.5
	Parsol MCX	0.0	0.0	6.0
	Unimer U-151(PVP/Hexadecene copolymer)	2.0	2.0	2.0
B	Unieide U-13 (methyl paraben)	0.3	0.3	0.3
	Liponic EQ-7 (Glycereth-7)	3.0	3.0	3.0
	Liponic 70 NC (sorbitol)	2.0	2.0	2.0
	Pentavitin (saccharide isomerate)	2.0	2.0	2.0
	Lipowax P-31(cetearyl alcohol and polysorbate)	1.5	1.5	1.5
	Melanin			
	Water			
	Total volumn	100ml	100ml	100ml

先將 phase A 及 phase B (已加入黑色素)分別加熱至 80 °C，待完全溶解後將 phase A 慢慢加入 phase B 並且不斷攪拌，直到溫度降到室溫備用。

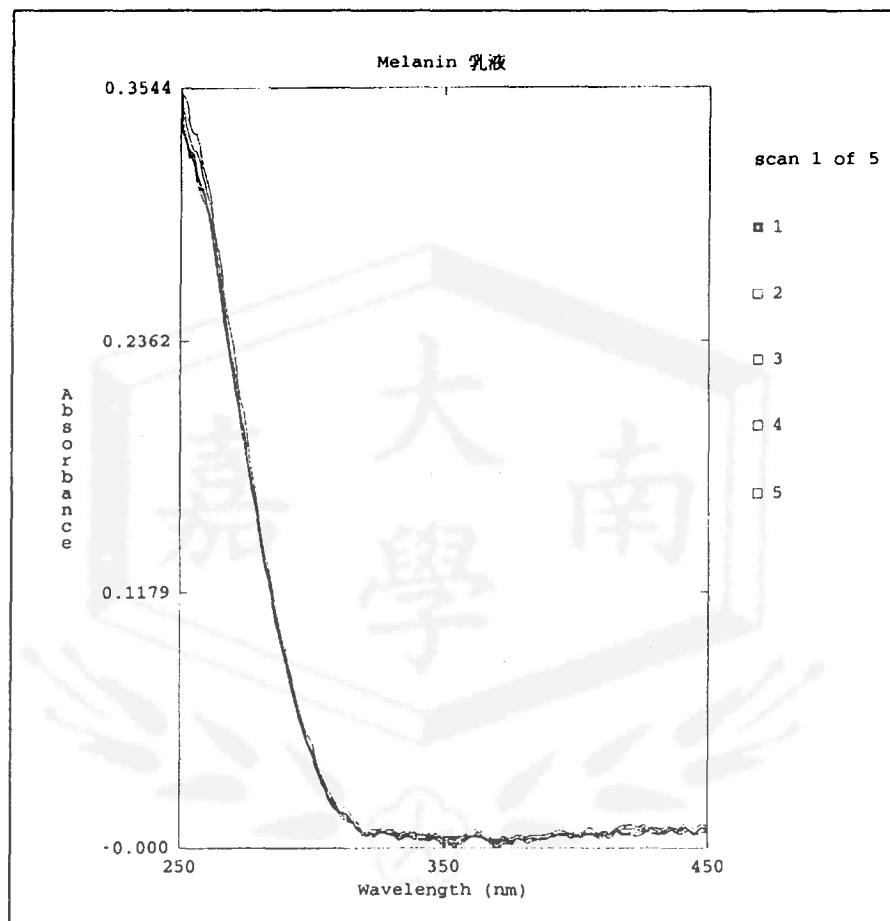


圖 8-1、黑色素之紫外線吸收光譜

Labsphere Ultraviolet Transmittance Analyzer SPF Report

Sample: Melanin 乳液
 Operator:
 Client: 88/7/7 3M
 Comment: 0.0250-0.0159
 Date: 7 July 1999
 Time: 5:27 pm
 Wavelength Range: 290 - 400 nm

Units:	SPF	T(UVA)	T(UVB)
# of Scans:	5	5	5
Mean:	1.05%	98.86%	87.11%
STD:	0.00%	0.24%	0.38%
COV:	0.33%	0.24%	0.43%
UVA Ratio:	0.13		
Star Category:	-	Too low for a UVA claim	

Scan #	SPF	Critical Wavelength	Scan #	SPF	Critical Wavelength
1	1.06	372 nm	7		
2	1.05	372 nm	8		
3	1.05	362 nm	9		
4	1.05	364 nm	10		
5	1.05	364 nm	11		
6			12		

圖 8-2、黑色素之紫外線吸收能力

6.6 黑色素防曬劑對皮膚色澤的影響

為了探討黑色素防曬化妝品對皮膚色澤的影響程度，於是對自願者進行黑色素防曬劑塗抹試驗。首先在手臂內外側皮膚上選定約 20 cm² 之區域分別塗抹含黑色素防曬化妝品，20 分鐘後利用皮膚色澤計 (Minolta CM 508i) 比較塗抹防曬劑及未塗抹部位皮膚色澤 L*a*b* 變化，其原理是由分光測色計射出白光，此光線遇到皮膚反射回積分球，再經過光線感應器測出反射的光線量，測色結果以 1976 年國際照明協會(Commission Internationale de l'Eclairage, CIE) 所定義的色彩空間 (color space) L* a* b* 值為表示方法[7, 8]，L* 值為明亮度可代表皮膚顏色的深淺，而 a* b* 值則分別代表紅色度及黃色度，其計算公式如下：

$$L^* = 116 \left(\frac{Y}{Y_0} \right)^{1/3} - 16 \quad a^* = 500 \left[\left(\frac{X}{X_0} \right)^{1/3} - \left(\frac{Y}{Y_0} \right)^{1/3} \right] \quad b^* = 200 \left[\left(\frac{Y}{Y_0} \right)^{1/3} - \left(\frac{Z}{Z_0} \right)^{1/3} \right]$$

X₀, Y₀ 及 Z₀ 為放射出之光線量，X/X₀, Y/Y₀ and Z/ Z₀ 必須大於 0.008856。

表 2、黑色素對皮膚色澤的影響評估

	手臂外側		手臂內側	
	塗抹前	塗抹後	塗抹前	塗抹後
L*	65.23 ±0.25	65.12 ±0.26	68.66 ±0.27	68.56 ±0.24
a*	9.65 ±0.15	9.60 ±0.15	8.86 ±0.12	8.78 ±0.13
b*	15.36 ±0.18	15.38 ±0.14	14.37 ±0.11	14.33 ±0.10

6.7 含黑色素防曬化粧品之紫外線吸收光譜測定:

製備好之防曬產品以防曬係數測定儀測定紫外線吸收光譜，方法如下：

7. 以電動天平秤取 1 公克樣品。
8. 以 10 ml 有機溶劑溶解，如不易溶解則利用超音波震盪處理。
9. 取 1 ml 加入 9 ml 有機溶劑中，連續進行十倍稀釋三次，直到最後濃度為 0.01 % 。
10. 取 2 ml 之最終稀釋液置於紫外線光譜儀測試管中。
11. 紫外線光譜儀先暖機，然後以有機溶劑做背景校正。
12. 使用 250~400 nm 光源進行樣品紫外線吸收光譜測定。

SPF 值過去以人體試驗進行測定，但是因為此方法相當耗時且費事，因此各國均極力尋找替代方法，有人改以動物作為試驗對象，不過，在保護動物的聲浪中，利用活體外測定 SPF 值將是未來的趨勢。本實驗為了確定活體外 SPF 值能符合人體測定之 SPF 值，我們以 FDA SPF 4 標準樣品(已經過 20 人測定過)進行 *In vitro* SPF 測試儀 UV1000s 測試，利用此方法而得到的 SPF 值為 4.51 與人體試驗所得到的 SPF 值 (4.35)相當接近，證實此方法具有可行性。

表 3、FDA SPF 4 標準樣品配方

成份	含量
Methylparaben	0.10
Disodium EDTA	0.05
Propylene Glycol	5.00
Triethanolamine	1.00
Lanolin	5.00
Homosalate	8.00
White Petrolatum	2.50
Stearic Acid	4.00
Propylparaben	0.05
Water	74.3

表 4、FDA SPF 4 標準樣品 SPF 人體測試值

編號	性別	SPF 值	編號	性別	SPF 值
1	F	5.0	11	F	4.0
2	F	4.0	12	M	4.0
3	F	4.0	13	F	4.0
4	F	4.0	14	F	5.0
5	M	5.0	15	F	4.0
6	F	4.0	16	F	5.0
7	F	5.0	17	F	4.0
8	F	4.0	18	F	4.0
9	F	5.0	19	F	5.0
10	F	4.0	20	F	4.0

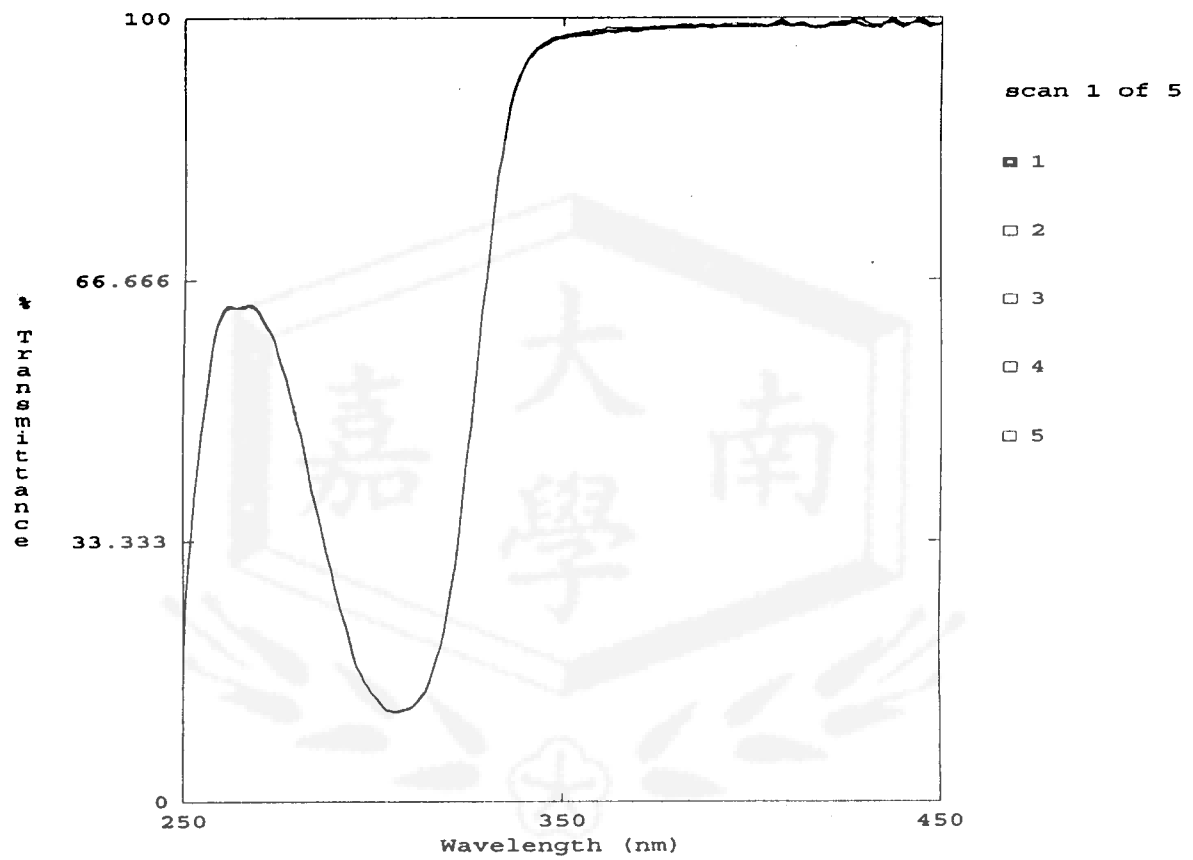


圖 9、SPF 標準品紫外線穿透光譜

6.8 市售防曬產品之有效性評估：

目前市面上的防曬化粧品種類繁多，本計畫收集市面上主要防曬化粧品品牌（包括化學性及物理性防曬劑），選擇較具代表性的產品與含黑色素防曬化粧品進行有效性比較，比較項目包括紫外線吸收波長的寬度及防曬係數等。測試結果如下表所示：

表 5、市售防曬產品之有效性評估

編號	標示 SPF 值	3M tape 測定值	UVA/UVB	UVA CRITICAL WAVELENGTH(nm)	UVA star rating
01	15	20.40	★	362	★★★★
02	15+	27.75	★★	381	★★★★★
03	15	9.85	★	348	★★
04	15	12.37	★	353	★★★★
05	15	31.26	★★	377	★★★★★
06	15	20.64	★	358	★★★★
07	15	11.59	★	368	★★★★
08	25	13.15	★★★★	381	★★★★★

09	14	28.00	★★★	383	★★★★★
10	10	17.25	★★	383	★★★★★
11	15	16.79	★★	382	★★★★★
12	12	11.42	★★★★★	388	★★★★★
13	17	17.71	★★★	386	★★★★★
14	15	9.02	-	335	★
15	15	15.76	★	352	★★★
16	15	19.72	★	373	★★★
17	15	7.07	-	336	★★
18	15	20.58	★	374	★★★★★
19	15	16.05	★	355	★★★
20	15	10.73	-	346	★★
21	23	19.91	★★	388	★★★★★
22	17	14.49	★★★	388	★★★★★

23	15	13.45	★★★	387	★★★★
24	15	17.02	★★★★	388	★★★★
25	20	22.10	★★★	387	★★★★
26	26	20.26	★★★★	388	★★★★



七、已完成之工作項目：

1. 黑色素之大量表現
2. 高產量黑色素生產條件的確立
3. 黑色素之製備與純化。
4. 含黑色素防曬化粧品之製備。
5. 含黑色素防曬化粧品紫外線吸收光譜測定。
6. 含黑色素防曬化粧品 SPF 值之測定。
7. 含黑色素防曬化粧品有效性評估。
8. 含黑色素防曬化粧品與市售產品有效性比較。

八、具體貢獻：

1. 將基因工程技術應用至化粧品。
2. 防曬化粧品有效性的提昇。
3. 提供防曬化粧品製造之新方向。

九、結論：

本計畫已完成酪胺酸酶基因之選殖，並進行酪胺酸酶基因表現及基因產物之分析工作。利用 mushroom 酪胺酸酶，已完成黑色素生產條件的建立，並且能生產對水溶解度甚高之黑色素，其色素顆粒小於 0.45 μ m，熱安定分析顯示黑色素在乳化溫度下仍然具有紫外線吸收能力。利用上述所生產之黑色素已完成含防曬乳液製備，其外觀呈現灰色，人體塗抹後，經過皮膚色澤計測定，不會改變膚色。

評估黑色素防曬乳液之效果，我們發現黑色素之 UVA 及 UVB 吸收能力極佳，但是製成乳液後，效果不甚理想，希望未來嘗試改變配方以增加其效果，或者與其它防曬成份搭配以加強其效力。對於市售防曬乳液之效果評估，結果顯示市售產品具 UVB 防護能力，然而對 UVA 之防護則待加強。因此開發黑色素防曬具有很大的潛力。

本計畫成功地利用 *in vitro* 方法得到具有商業價值之黑色素，同時也開發出水溶性黑色素之生產條件，此方法有別於美國專利所提及之水溶性黑色素，相當具有發展潛力。有關成果，建議向中華民國專利局申請專利，並希望延續目前之工作，將黑色素應用到其他產品，例如製成紫外線隔離效果之隔熱紙；製成具隔離紫外線之太陽眼鏡及加入塑膠製品以防止紫外線引起塑膠老化現象。

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附錄

編號 01 防曬化粧品有效性分析

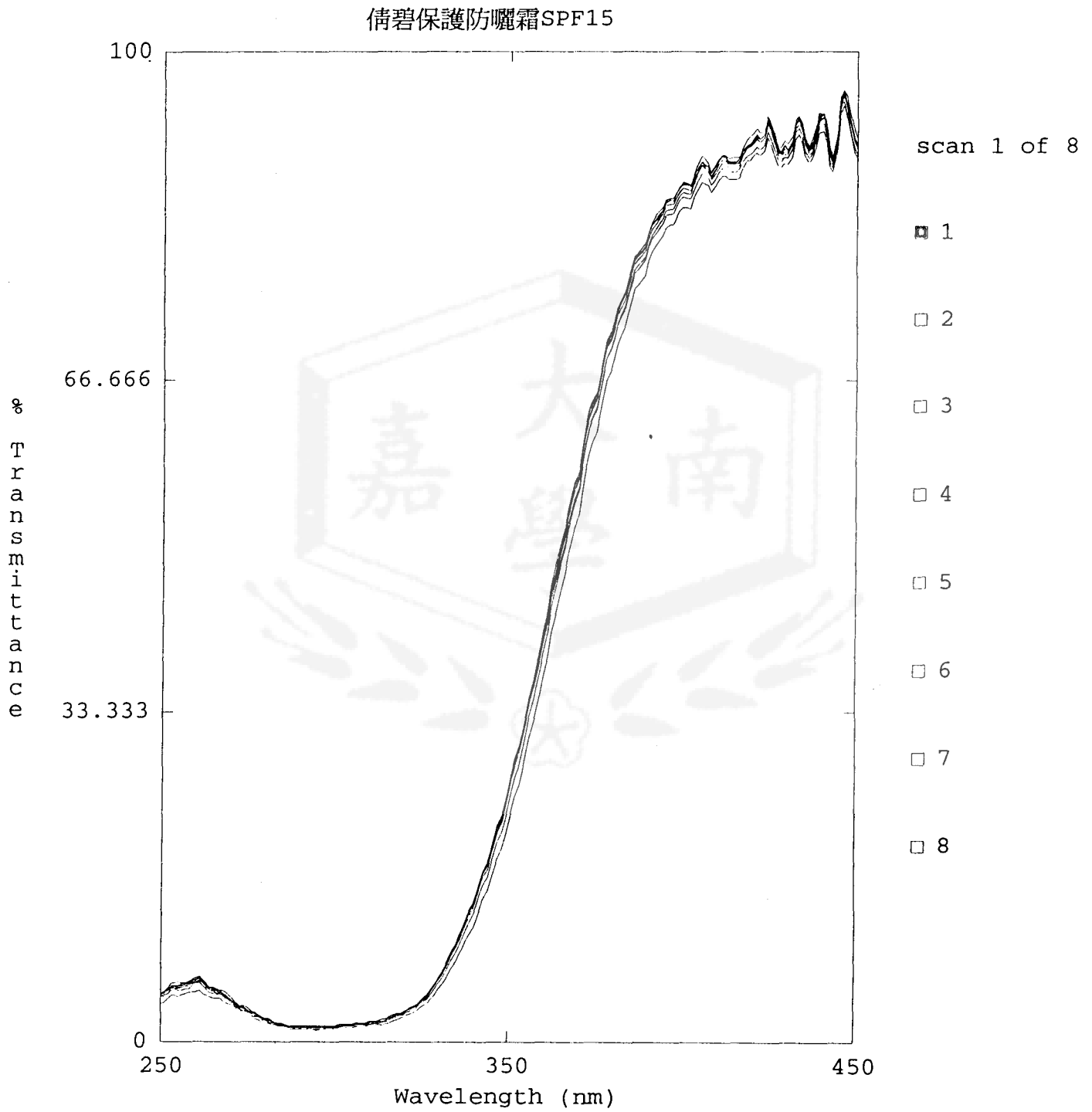
Labsphere Ultraviolet Transmittance Analyzer

SPF Report

Sample: 倩碧保護防曬霜SPF15
 Operator:
 Client:
 Comment:
 Date: 5 Feb 1999
 Time: 5:04 pm
 Wavelength Range: 290 - 400 nm
 Units: SPF T(UVA) T(UVB)
 # of Scans: 8 8 8
 Mean: 20.40% 39.98% 1.62%
 STD: 0.86% 0.93% 0.11%
 COV: 4.22% 2.32% 6.88%
 UVA Ratio: 0.31
 Star Category: * MODERATE

Scan #	SPF	Critical Wavelength	Scan #	SPF	Critical Wavelength
1	20.31	354 nm	7	20.02	354 nm
2	20.15	354 nm	8	20.69	355 nm
3	19.88	355 nm	9		
4	22.37	355 nm	10		
5	20.26	354 nm	11		
6	19.54	354 nm	12		

編號 01 防曬化粧品紫外線穿透圖譜



編號 02 防曬化粧品有效性分析

Labsphere Ultraviolet Transmittance Analyzer SPF Report

Sample: 旁氏隔離霜
 Operator:
 Client: 3M 21.0度 40%
 Comment: 0.0251-0.0147
 Date: 5 Feb 1999
 Time: 5:09 pm
 Wavelength Range: 290 - 400 nm

Units:	SPF	T(UVA)	T(UVB)
# of Scans:	7	7	7
Mean:	27.75%	20.01%	2.03%
STD:	1.20%	0.60%	0.11%
COV:	4.32%	3.00%	5.31%
UVA Ratio:	0.45		
Star Category:	**	GOOD	

Scan #	SPF	Critical Wavelength	Scan #	SPF	Critical Wavelength
1	25.60	375 nm	7	27.61	375 nm
2	28.96	376 nm	8		
3	27.24	375 nm	9		
4	28.57	375 nm	10		
5	27.31	375 nm	11		
6	28.94	376 nm	12		

編號 03 防曬化粧品有效性分析

Labsphere Ultraviolet Transmittance Analyzer

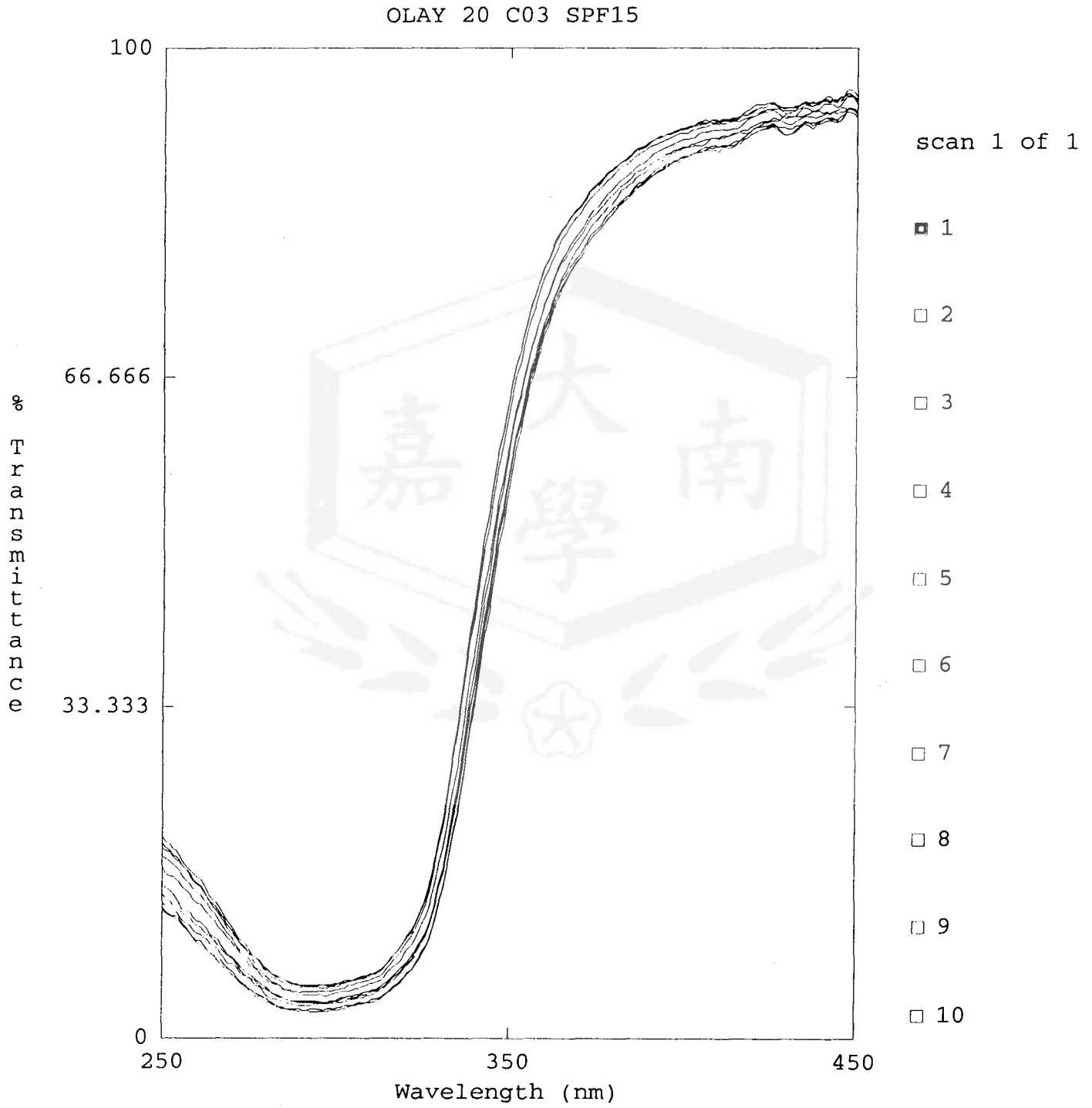
SPF Report

Sample: OLAY 20 C03 SPF15
 Operator:
 Client:
 Comment:
 Date: 9 Feb 1999
 Time: 5:09 pm
 Wavelength Range: 290 - 400 nm

Units:	SPF	T(UVA)	T(UVB)
# of Scans:	10	10	10
Mean:	9.85%	58.56%	4.56%
STD:	1.24%	2.43%	1.03%
COV:	12.58%	4.15%	22.62%
UVA Ratio:	0.22		
Star Category	*	MODERATE	

Scan #	SPF	Critical Wavelength	Scan #	SPF	Critical Wavelength
1	10.73	345 nm	7	8.51	344 nm
2	10.55	346 nm	8	10.19	344 nm
3	11.54	345 nm	9	11.60	344 nm
4	9.49	345 nm	10	8.48	343 nm
5	8.54	343 nm	11		
6	8.84	343 nm	12		

編號 03 防曬化粧品紫外線穿透圖譜



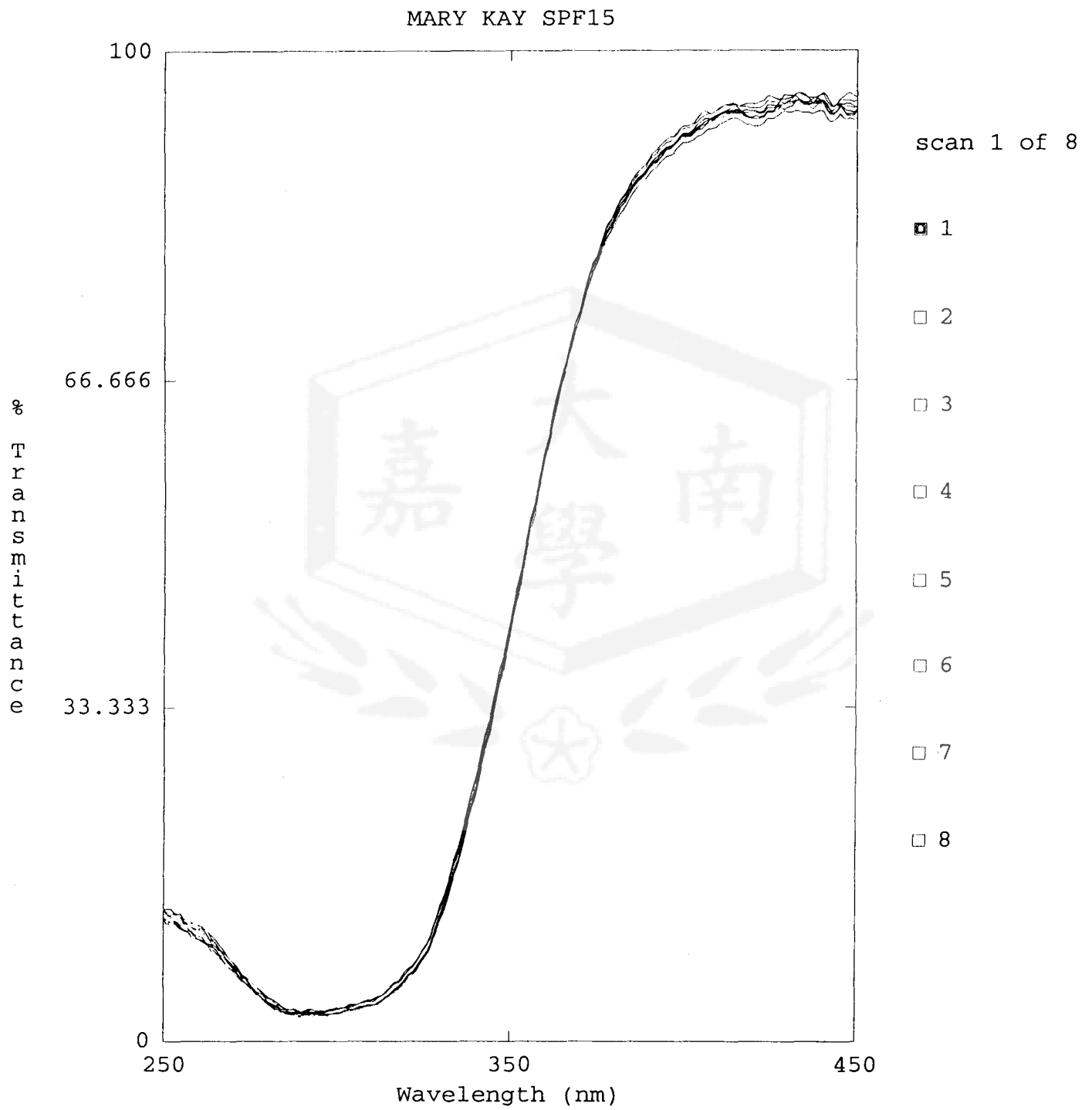
編號 04 防曬化粧品有效性分析

Labsphere Ultraviolet Transmittance Analyzer SPF Report

Sample: MARY KAY SPF15
 Operator:
 Client:
 Comment:
 Date: 8 Feb 1999
 Time: 11:03 am
 Wavelength Range: 290 - 400 nm
 Units: SPF T(UVA) T(UVB)
 # of Scans: 8 8 8
 Mean: 12.37% 51.01% 3.32%
 STD: 0.41% 0.28% 0.24%
 COV: 3.31% 0.55% 7.17%
 UVA Ratio: 0.26
 Star Category: * MODERATE

Scan #	SPF	Critical Wavelength	Scan #	SPF	Critical Wavelength
1	11.84	350 nm	7	12.03	350 nm
2	12.71	350 nm	8	12.57	349 nm
3	12.70	349 nm	9		
4	12.74	349 nm	10		
5	12.56	350 nm	11		
6	11.78	350 nm	12		

編號 04 防曬化粧品紫外線穿透圖譜



編號 05 防曬化粧品有效性分析

Labsphere Ultraviolet Transmittance Analyzer SPF Report

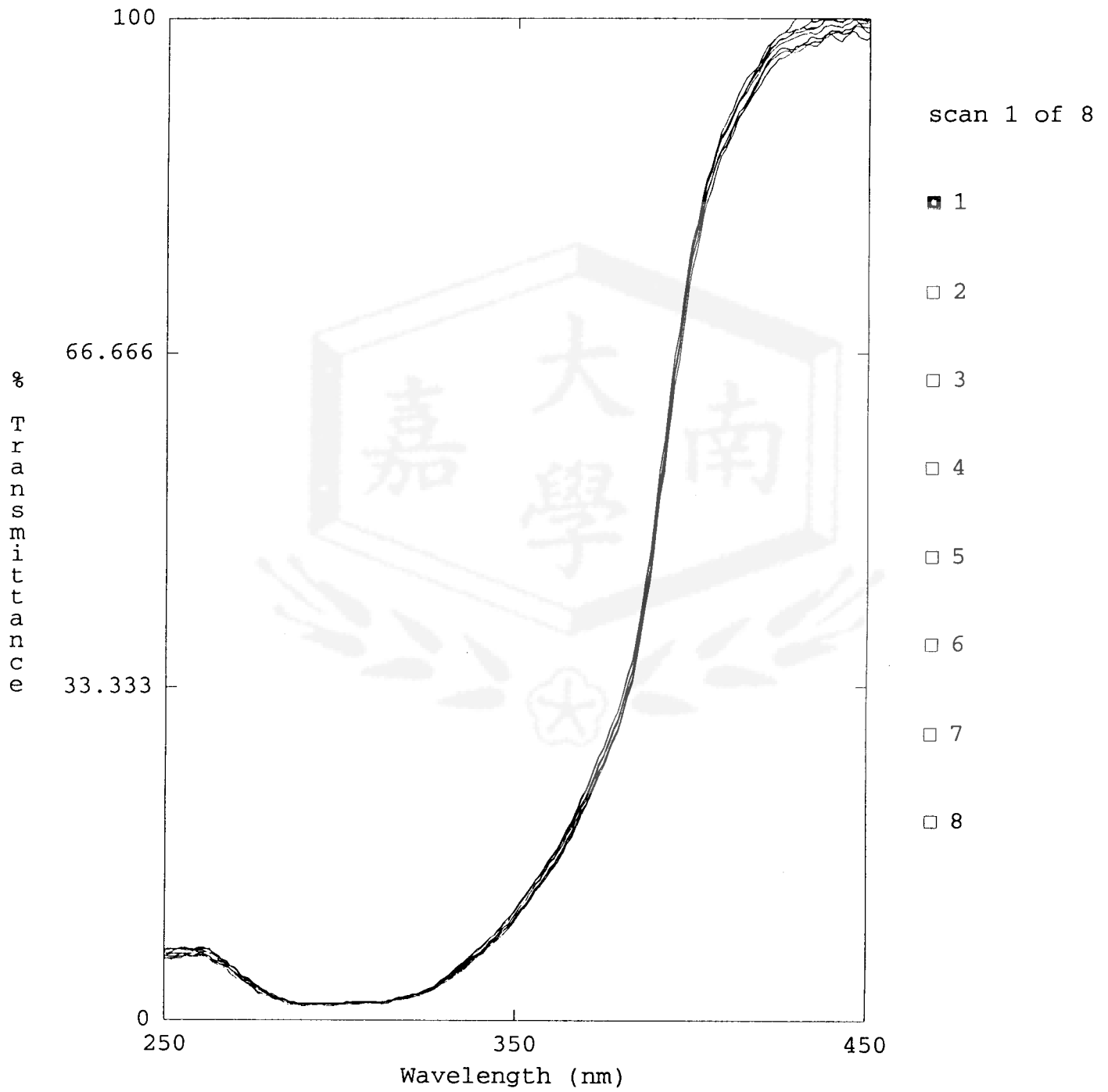
Sample: 白雪36 C05 SPF15
 Operator:
 Client:
 Comment:
 Date: 10 Feb 1999
 Time: 3:24 pm
 Wavelength Range: 290 - 400 nm

Units:	SPF	T(UVA)	T(UVB)
# of Scans:	8	8	8
Mean:	31.26%	21.34%	1.74%
STD:	1.02%	0.48%	0.08%
COV:	3.25%	2.27%	4.56%
UVA Ratio:	0.48		
Star Category:	**	GOOD	

Scan #	SPF	Critical Wavelength	Scan #	SPF	Critical Wavelength
1	31.99	371 nm	7	30.05	370 nm
2	30.90	370 nm	8	30.28	370 nm
3	30.16	370 nm	9		
4	32.06	371 nm	10		
5	32.38	370 nm	11		
6	32.29	370 nm	12		

編號 05 防曬化粧品紫外線穿透圖譜

白雪36 C05 SPF15



編號 06 防曬化粧品有效性分析

Labsphere Ultraviolet Transmittance Analyzer

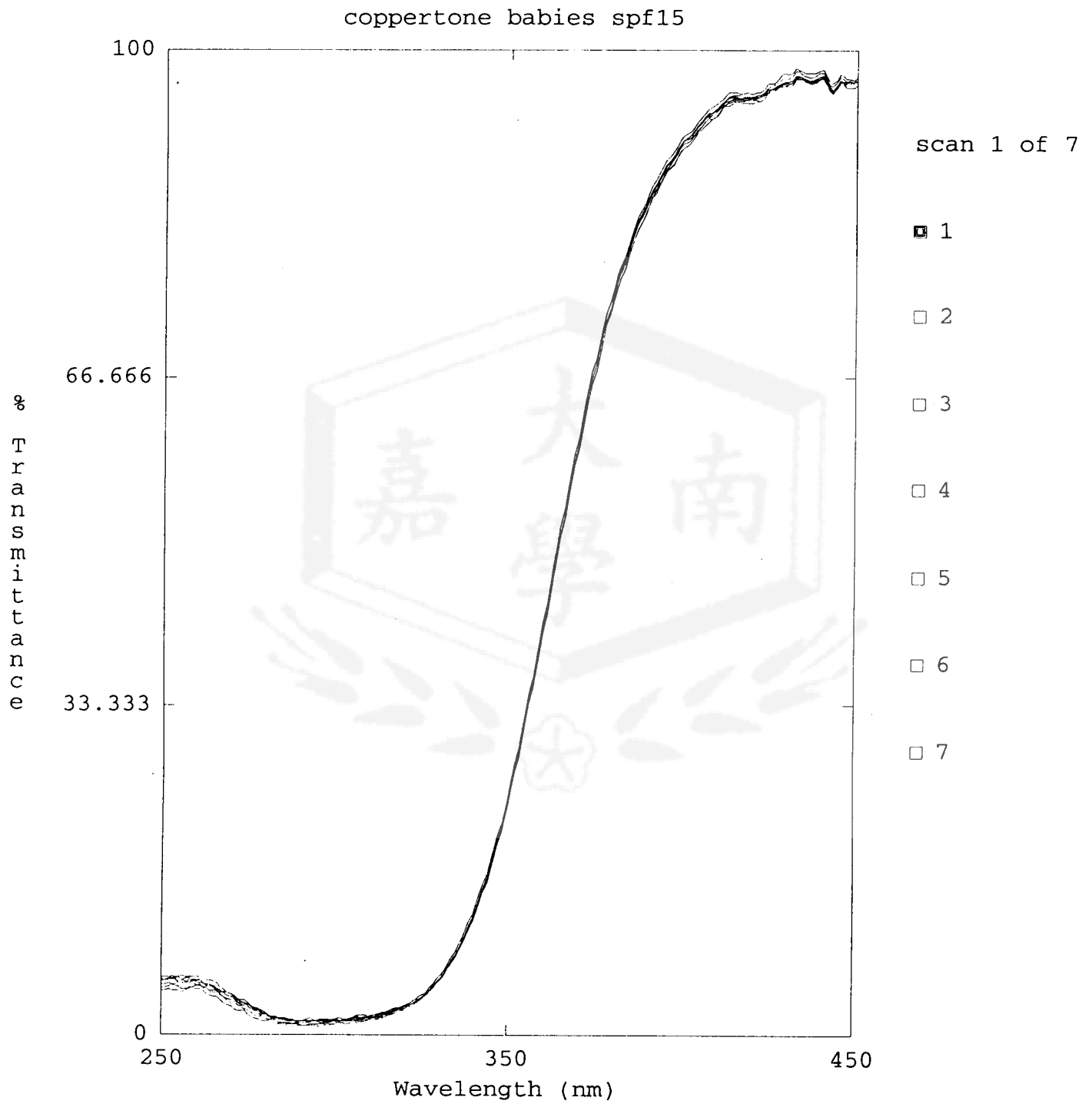
SPF Report

Sample: coppertone babies spf15
 Operator:
 Client:
 Comment:
 Date: 8 Feb 1999
 Time: 11:12 am
 Wavelength Range: 290 - 400 nm

Units:	SPF	T(UVA)	T(UVB)
# of Scans:	7	7	7
Mean:	20.64%	41.19%	1.47%
STD:	0.73%	0.32%	0.21%
COV:	3.55%	0.77%	14.02%
UVA Ratio:	0.31		
Star Category:	*	MODERATE	

Scan #	SPF	Critical Wavelength	Scan #	SPF	Critical Wavelength
1	20.92	353 nm	7	21.70	352 nm
2	20.37	353 nm	8		
3	19.52	353 nm	9		
4	21.33	352 nm	10		
5	20.21	353 nm	11		
6	20.46	353 nm	12		

編號 06 防曬化粧品紫外線穿透圖譜



編號 07 防曬化粧品有效性分析

Labsphere Ultraviolet Transmittance Analyzer SPF Report

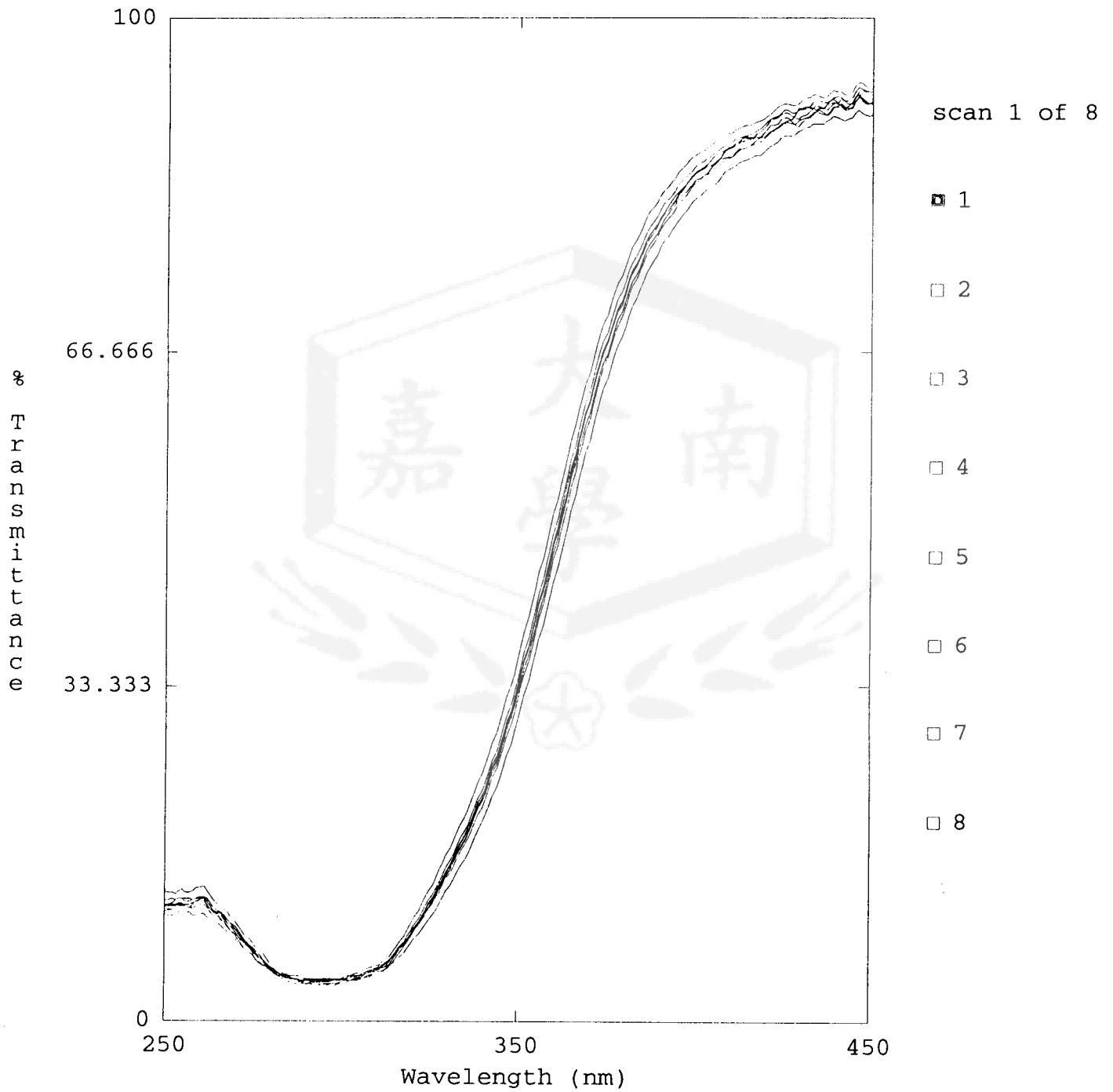
Sample: 美爽爽思譜律防曬乳液
 Operator:
 Client:
 Comment:
 Date: 26 Feb 1999
 Time: 10:55 am
 Wavelength Range: 290 - 400 nm

Units:	SPF	T(UVA)	T(UVB)
# of Scans:	8	8	8
Mean:	11.59%	44.83%	4.46%
STD:	0.55%	1.47%	0.23%
COV:	4.77%	3.29%	5.21%
UVA Ratio:	0.31		
Star Category:	*	MODERATE	

Scan #	SPF	Critical Wavelength	Scan #	SPF	Critical Wavelength
1	11.39	358 nm	7	11.68	358 nm
2	11.56	358 nm	8	11.94	358 nm
3	11.68	359 nm	9		
4	12.57	359 nm	10		
5	10.66	357 nm	11		
6	11.22	357 nm	12		

編號 07 防曬化粧品紫外線穿透圖譜

美爽爽思譜律防曬乳液



編號 08 防曬化粧品有效性分析

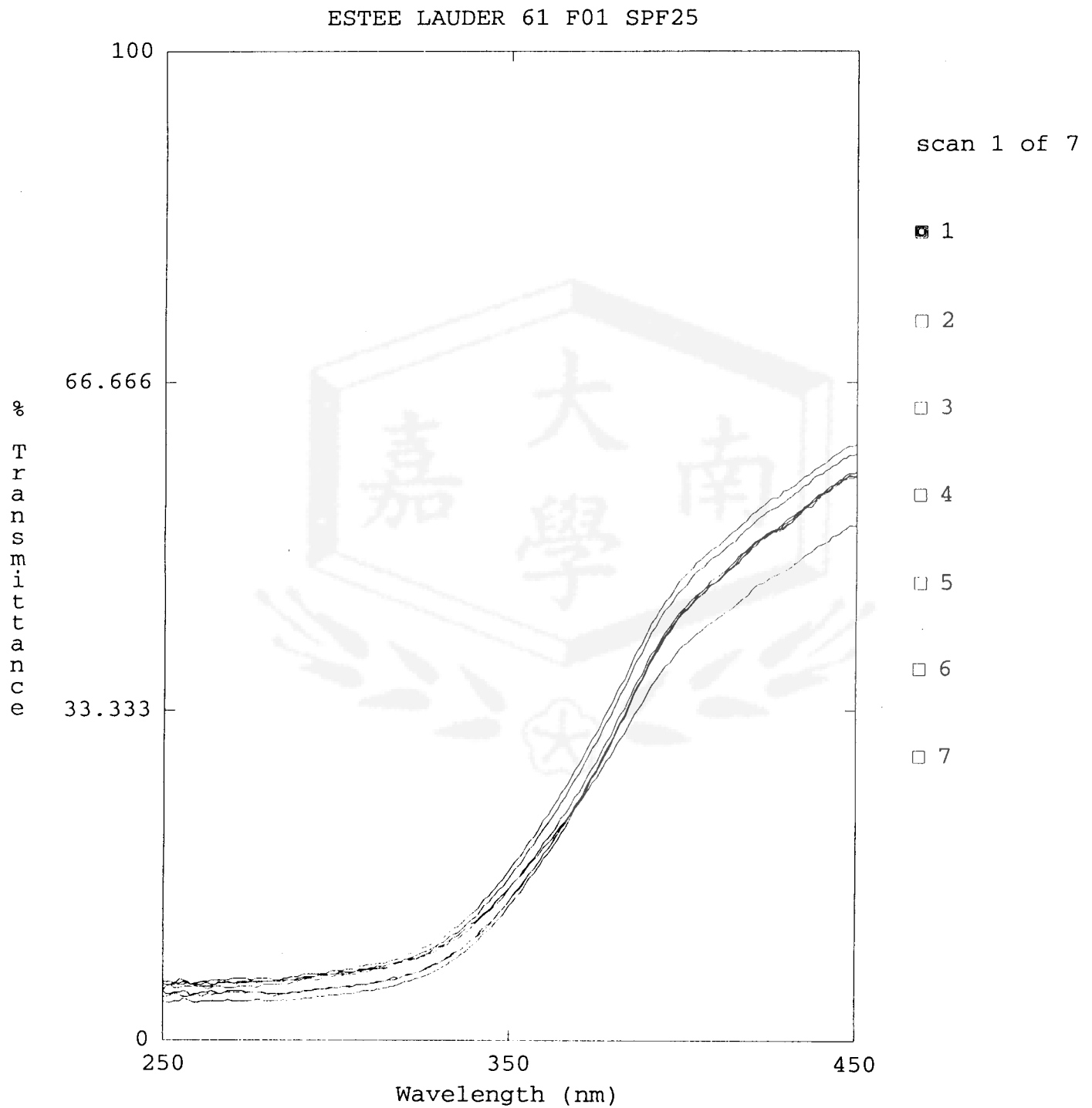
Labsphere Ultraviolet Transmittance Analyzer SPF Report

Sample: ESTEE LAUDER 61 F01 SPF25
 Operator:
 Client:
 Comment:
 Date: 9 Feb 1999
 Time: 3:27 pm
 Wavelength Range: 290 - 400 nm

Units:	SPF	T(UVA)	T(UVB)
# of Scans:	7	7	7
Mean:	13.15%	21.20%	6.00%
STD:	1.77%	1.35%	0.93%
COV:	13.49%	6.37%	15.45%
UVA Ratio:	0.60		
Star Category:	***	SUPERIOR	

Scan #	SPF	Critical Wavelength	Scan #	SPF	Critical Wavelength
1	11.70	378 nm	7	14.39	378 nm
2	14.41	378 nm	8		
3	12.29	380 nm	9		
4	11.25	378 nm	10		
5	12.03	379 nm	11		
6	15.99	378 nm	12		

編號 08 防曬化粧品紫外線穿透圖譜



編號 09 防曬化粧品有效性分析

Labsphere Ultraviolet Transmittance Analyzer

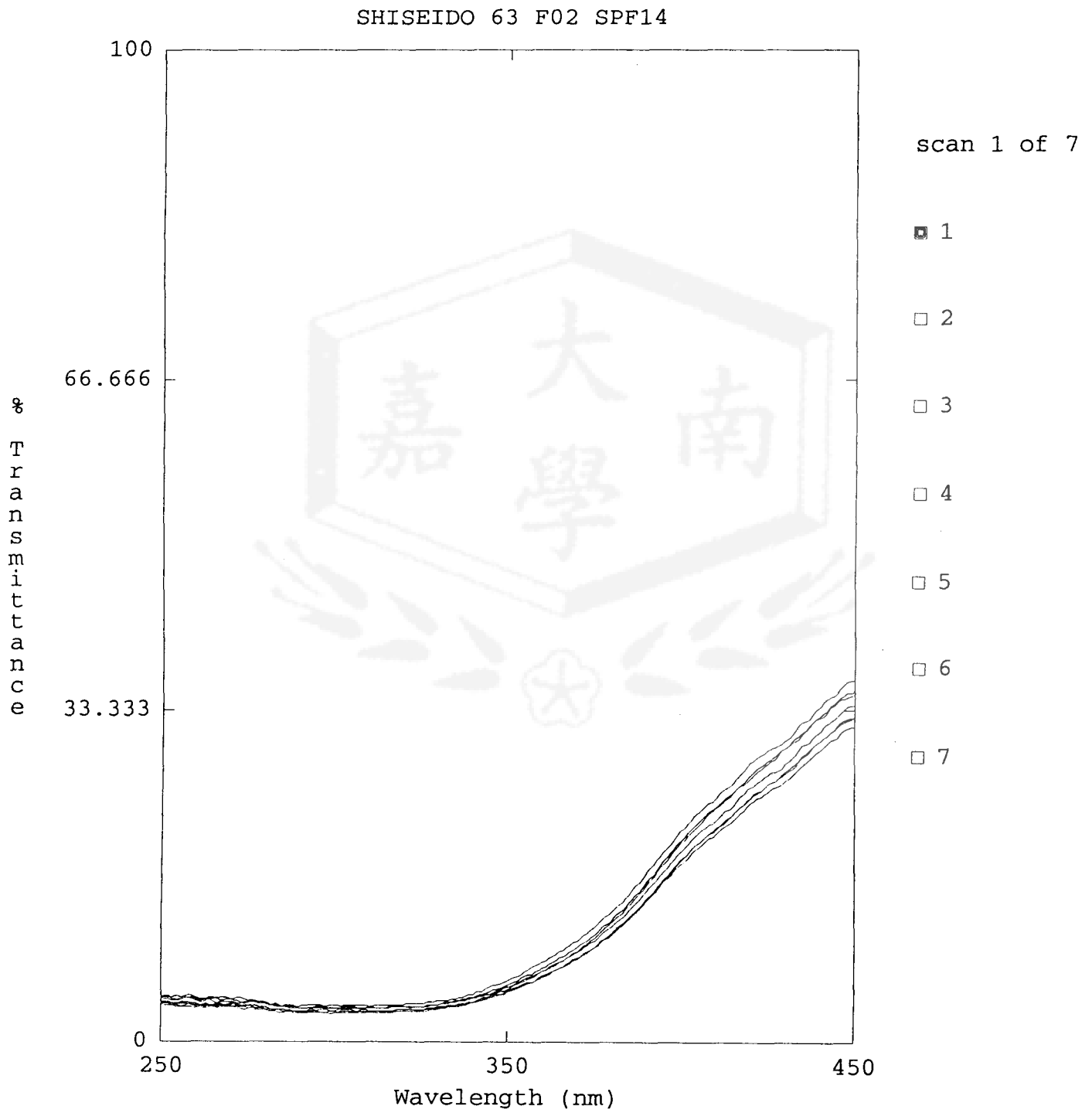
SPF Report

Sample: SHISEIDO 63 F02 SPF14
 Operator:
 Client:
 Comment:
 Date: 9 Feb 1999
 Time: 3:35 pm
 Wavelength Range: 290 - 400 nm

Units:	SPF	T(UVA)	T(UVB)
# of Scans:	7	7	7
Mean:	28.00%	8.14%	3.26%
STD:	2.20%	0.59%	0.28%
COV:	7.84%	7.23%	8.44%
UVA Ratio:	0.77		
Star Category:	***	SUPERIOR	

Scan #	SPF	Critical Wavelength	Scan #	SPF	Critical Wavelength
1	30.29	384 nm	7	24.67	383 nm
2	29.72	384 nm	8		
3	28.65	384 nm	9		
4	29.97	383 nm	10		
5	26.38	383 nm	11		
6	26.34	384 nm	12		

編號 09 防曬化粧品紫外線穿透圖譜



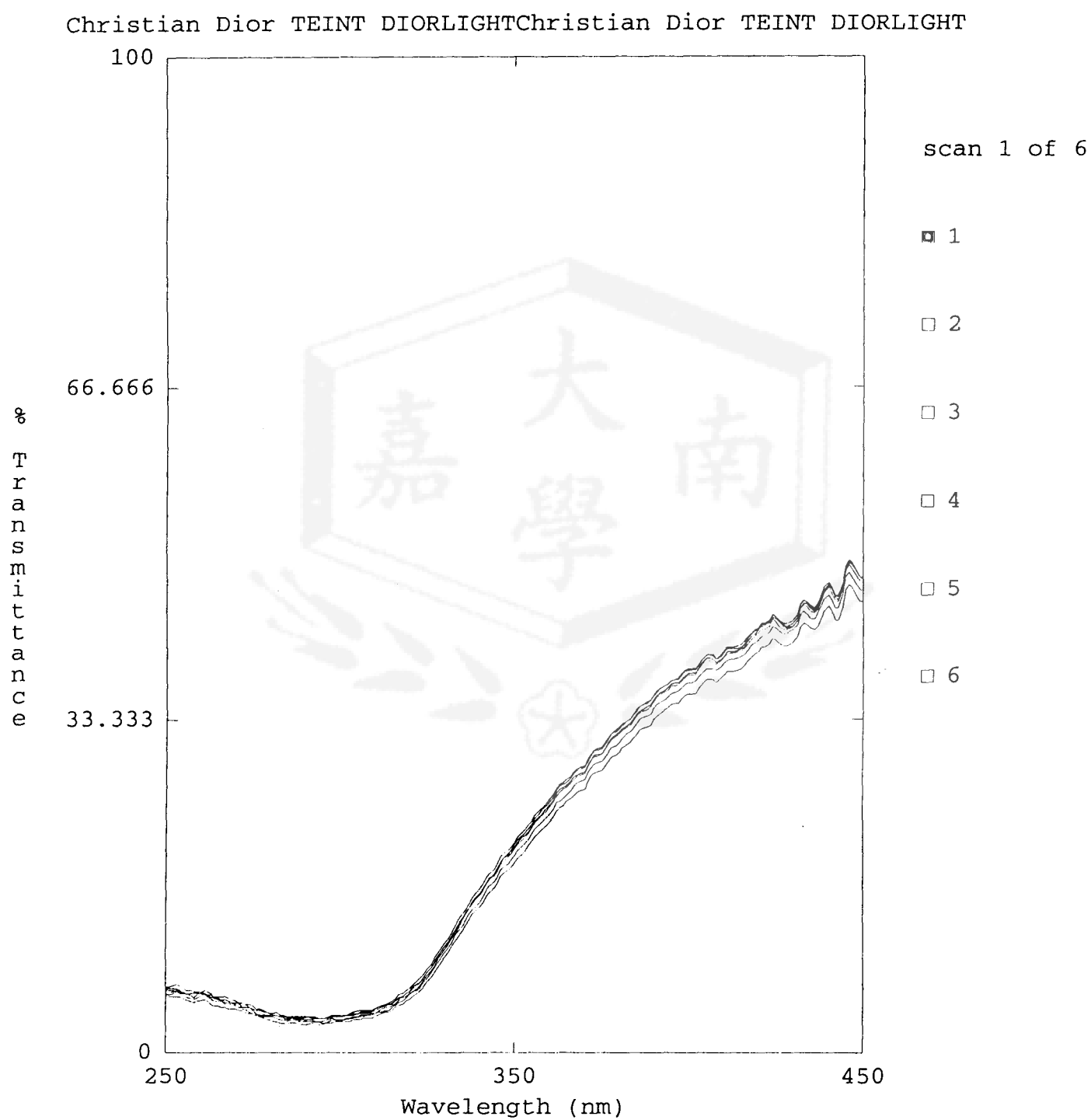
編號 10 防曬化粧品有效性分析

Labsphere Ultraviolet Transmittance Analyzer SPF Report

Sample: Christian Dior TEINT DIORLIGHT
 Operator:
 Client:
 Comment:
 Date: 5 Feb 1999
 Time: 4:07 pm
 Wavelength Range: 290 - 400 nm
 Units: SPF T(UVA) T(UVB)
 # of Scans: 6 6 6
 Mean: 17.25% 22.32% 3.57%
 STD: 1.02% 0.72% 0.27%
 COV: 5.91% 3.23% 7.45%
 UVA Ratio: 0.48
 Star Category: ** GOOD

Scan #	SPF	Critical Wavelength	Scan #	SPF	Critical Wavelength
1	16.68	380 nm	7		
2	17.93	379 nm	8		
3	18.89	380 nm	9		
4	17.27	379 nm	10		
5	16.06	380 nm	11		
6	16.69	380 nm	12		

編號 10 防曬化粧品紫外線穿透圖譜



編號 11 防曬化粧品有效性分析

Labsphere Ultraviolet Transmittance Analyzer

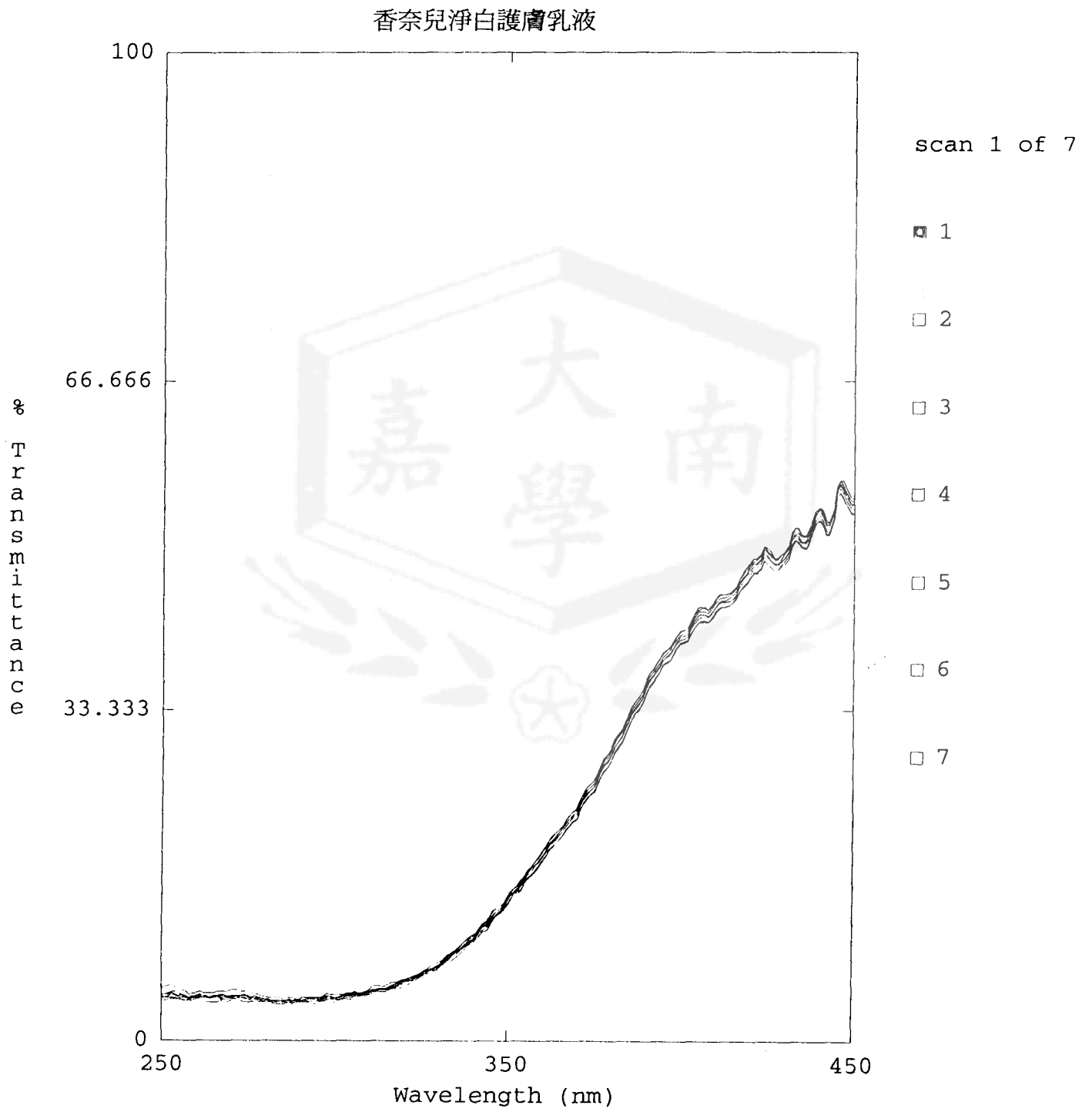
SPF Report

Sample: 香奈兒淨白護膚乳液
 Operator:
 Client:
 Comment:
 Date: 5 Feb 1999
 Time: 4:10 pm
 Wavelength Range: 290 - 400 nm

Units:	SPF	T(UVA)	T(UVB)
# of Scans:	7	7	7
Mean:	16.79%	19.35%	4.31%
STD:	0.60%	0.37%	0.20%
COV:	3.58%	1.91%	4.67%
UVA Ratio:	0.57		
Star Category:	**	GOOD	

Scan #	SPF	Critical Wavelength	Scan #	SPF	Critical Wavelength
1	16.39	378 nm	7	17.02	379 nm
2	15.87	379 nm	8		
3	17.20	378 nm	9		
4	16.60	379 nm	10		
5	16.70	378 nm	11		
6	17.74	379 nm	12		

編號 11 防曬化粧品紫外線穿透圖譜



編號 12 防曬化粧品有效性分析

Labsphere Ultraviolet Transmittance Analyzer

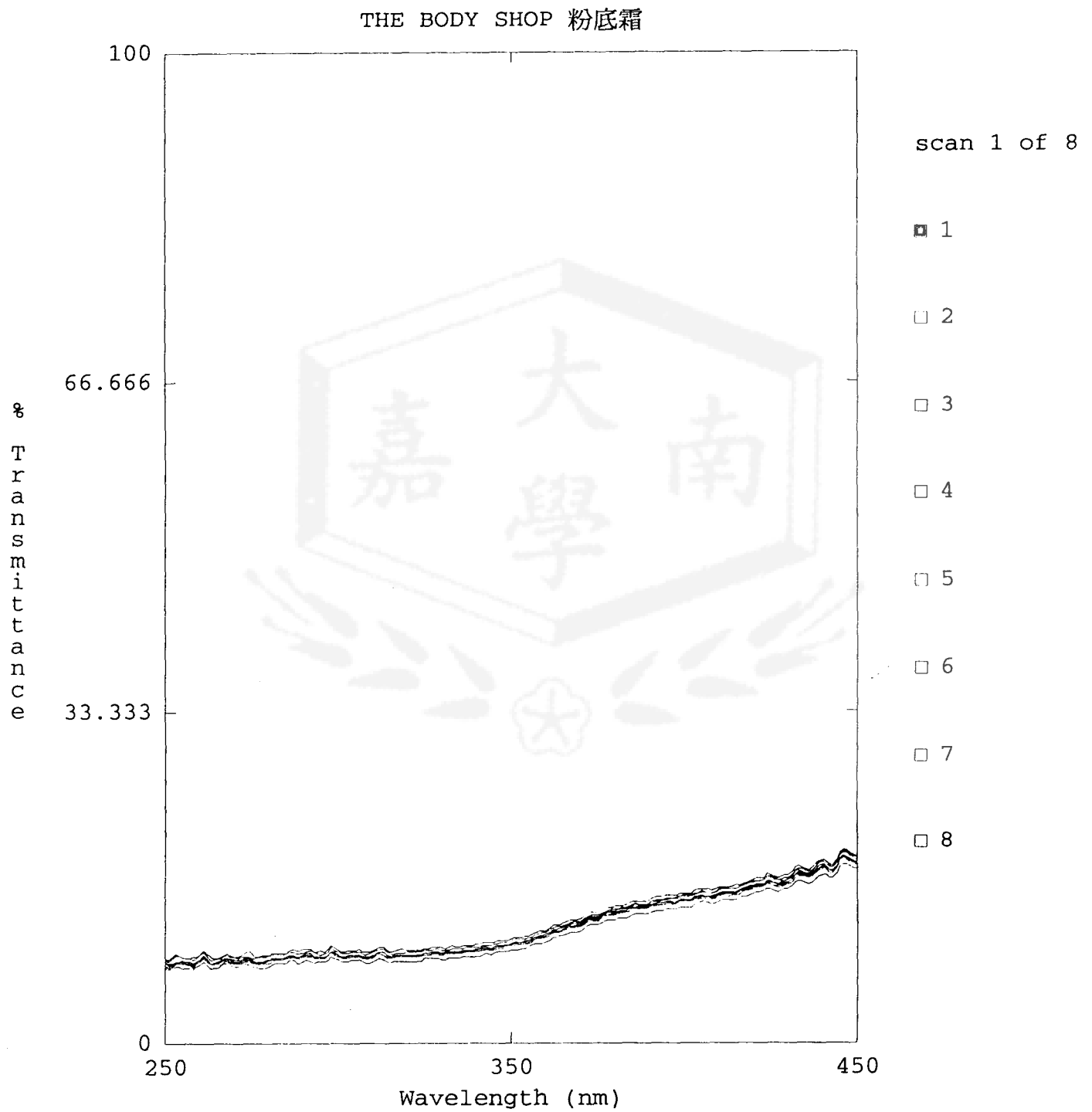
SPF Report

Sample: THE BODY SHOP 粉底霜
 Operator:
 Client:
 Comment:
 Date: 5 Feb 1999
 Time: 4:54 pm
 Wavelength Range: 290 - 400 nm

Units:	SPF	T(UVA)	T(UVB)
# of Scans:	8	8	8
Mean:	11.42%	10.81%	8.55%
STD:	0.41%	0.36%	0.32%
COV:	3.61%	3.31%	3.74%
UVA Ratio:	0.91		
Star Category:	****	MAXIMUM	

Scan #	SPF	Critical Wavelength	Scan #	SPF	Critical Wavelength
1	12.14	388 nm	7	11.01	388 nm
2	11.57	388 nm	8	11.45	388 nm
3	10.76	388 nm	9		
4	11.37	388 nm	10		
5	11.60	388 nm	11		
6	11.49	388 nm	12		

編號 12 防曬化粧品紫外線穿透圖譜



編號 13 防曬化粧品有效性分析

Labsphere Ultraviolet Transmittance Analyzer

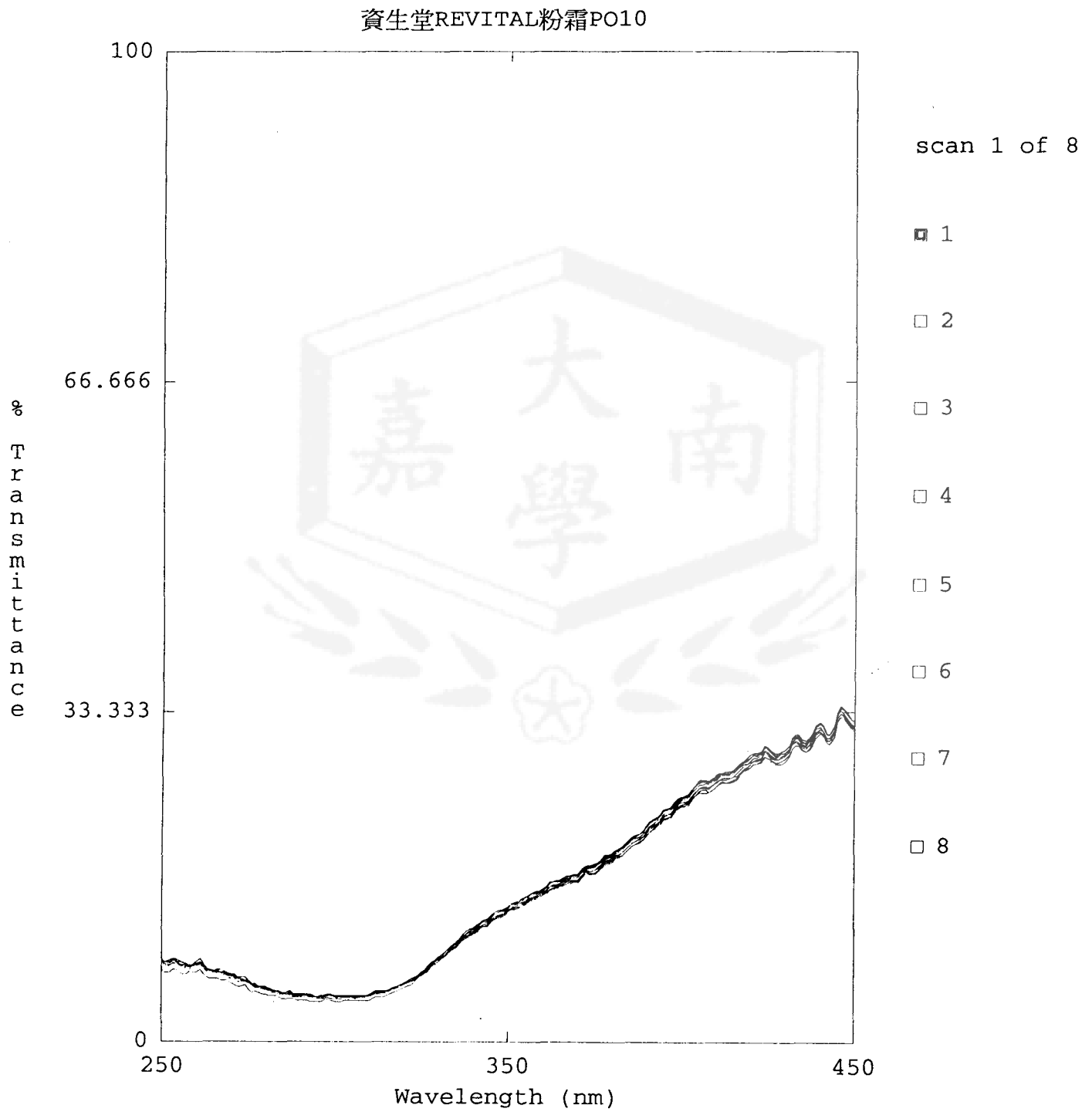
SPF Report

Sample: 資生堂REVITAL粉霜PO10
 Operator:
 Client:
 Comment:
 Date: 5 Feb 1999
 Time: 5:00 pm
 Wavelength Range: 290 - 400 nm

Units:	SPF	T(UVA)	T(UVB)
# of Scans:	8	8	8
Mean:	17.71%	14.41%	4.67%
STD:	0.48%	0.27%	0.18%
COV:	2.71%	1.87%	3.83%
UVA Ratio:	0.64		
Star Category:	***	SUPERIOR	

Scan #	SPF	Critical Wavelength	Scan #	SPF	Critical Wavelength
1	17.38	384 nm	7	17.51	384 nm
2	17.81	384 nm	8	17.50	384 nm
3	17.64	384 nm	9		
4	18.77	384 nm	10		
5	17.84	384 nm	11		
6	17.19	384 nm	12		

編號 13 防曬化粧品紫外線穿透圖譜



編號 14 防曬化粧品有效性分析

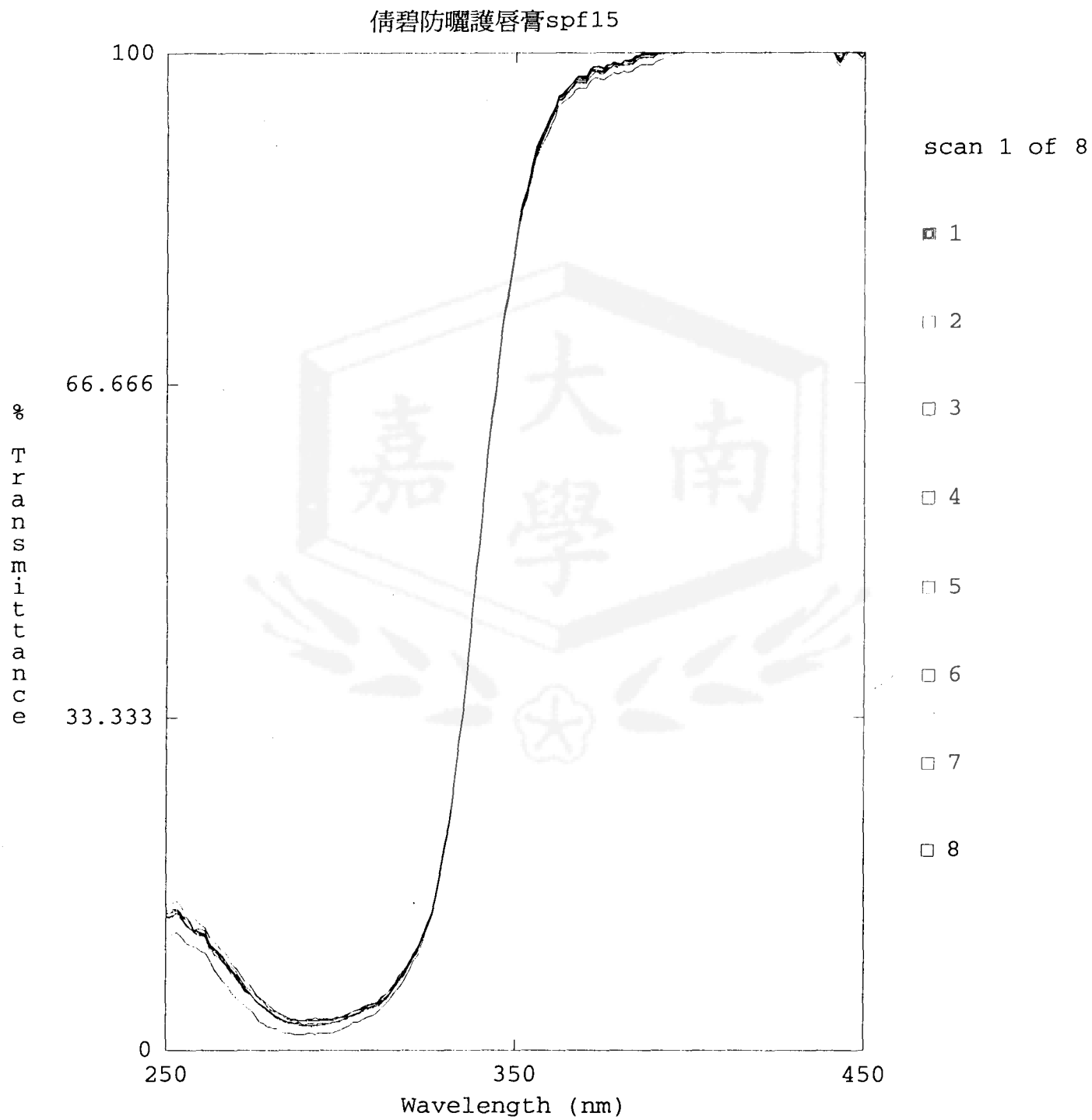
Labsphere Ultraviolet Transmittance Analyzer

SPF Report

Sample: 倩碧防曬護唇膏spf15
 Operator:
 Client:
 Comment:
 Date: 8 Feb 1999
 Time: 11:57 am
 Wavelength Range: 290 - 400 nm
 Units: SPF T(UVA) T(UVB)
 # of Scans: 8 8 8
 Mean: 9.02% 70.57% 3.33%
 STD: 0.26% 0.27% 0.40%
 COV: 2.83% 0.39% 11.95%
 UVA Ratio: 0.14
 Star Category: - Too low for a UVA claim

Scan #	SPF	Critical Wavelength	Scan #	SPF	Critical Wavelength
1	8.93	333 nm	7	8.96	333 nm
2	9.58	332 nm	8	9.04	333 nm
3	8.73	333 nm	9		
4	9.08	333 nm	10		
5	8.83	333 nm	11		
6	9.03	333 nm	12		

編號 14 防曬化粧品紫外線穿透圖譜



編號 15 防曬化粧品有效性分析

Labsphere Ultraviolet Transmittance Analyzer

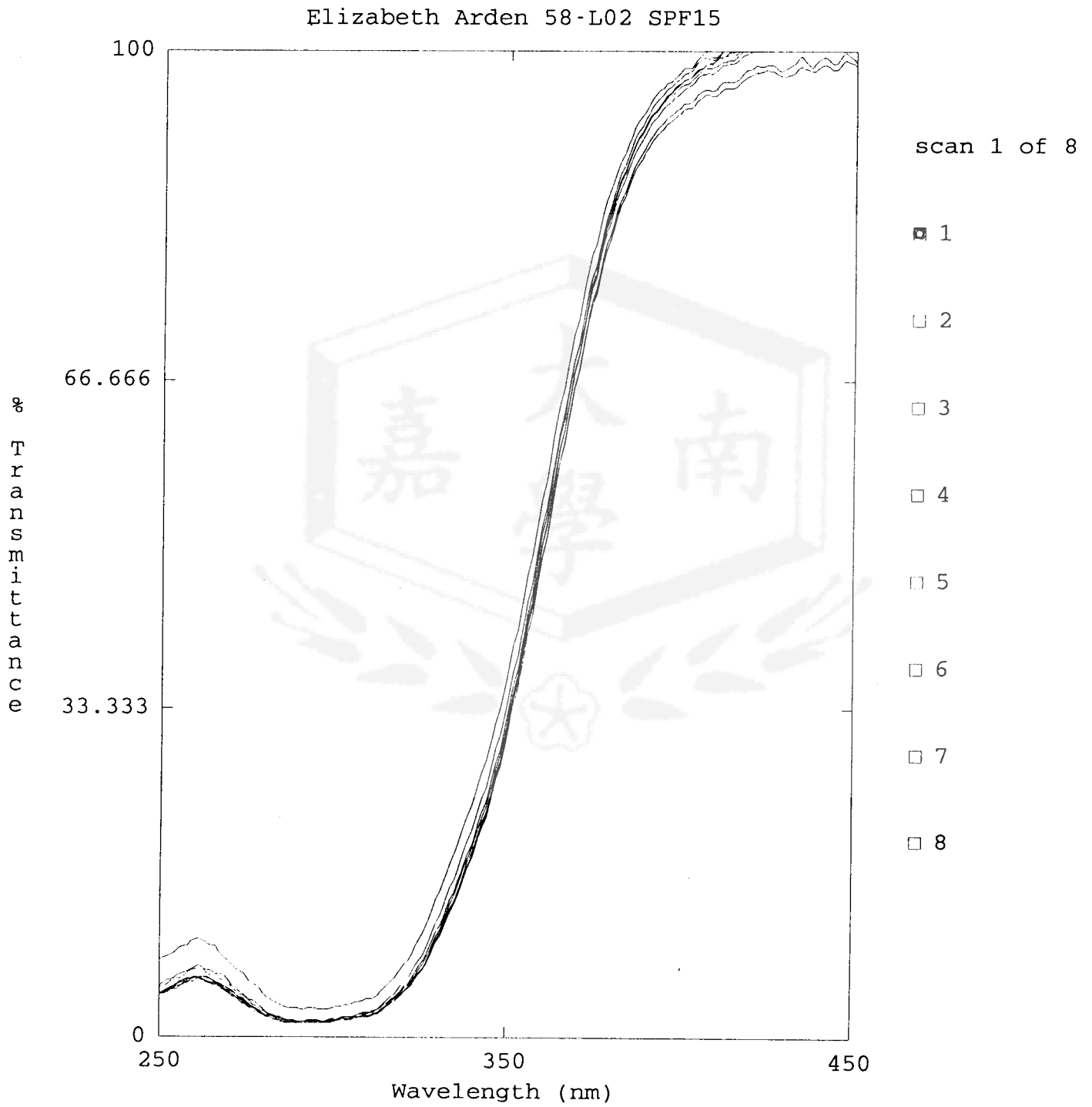
SPF Report

Sample: Elizabeth Arden 58-L02 SPF15
 Operator: Chen
 Client: 3M
 Comment: 0.0252-0.0182
 Date: 4 Feb 1999
 Time: 1:27 pm
 Wavelength Range: 290 - 400 nm

Units:	SPF	T(UVA)	T(UVB)
# of Scans:	8	8	8
Mean:	15.76%	48.51%	2.03%
STD:	1.49%	1.53%	0.55%
COV:	9.44%	3.16%	27.11%
UVA Ratio:	0.25		
Star Category:	*	MODERATE	

Scan #	SPF	Critical Wavelength	Scan #	SPF	Critical Wavelength
1	16.89	350 nm	7	16.76	350 nm
2	16.44	350 nm	8	12.38	350 nm
3	15.15	349 nm	9		
4	15.61	349 nm	10		
5	16.24	350 nm	11		
6	16.59	349 nm	12		

編號 15 防曬化粧品紫外線穿透圖譜



編號 16 防曬化粧品有效性分析

Labsphere Ultraviolet Transmittance Analyzer

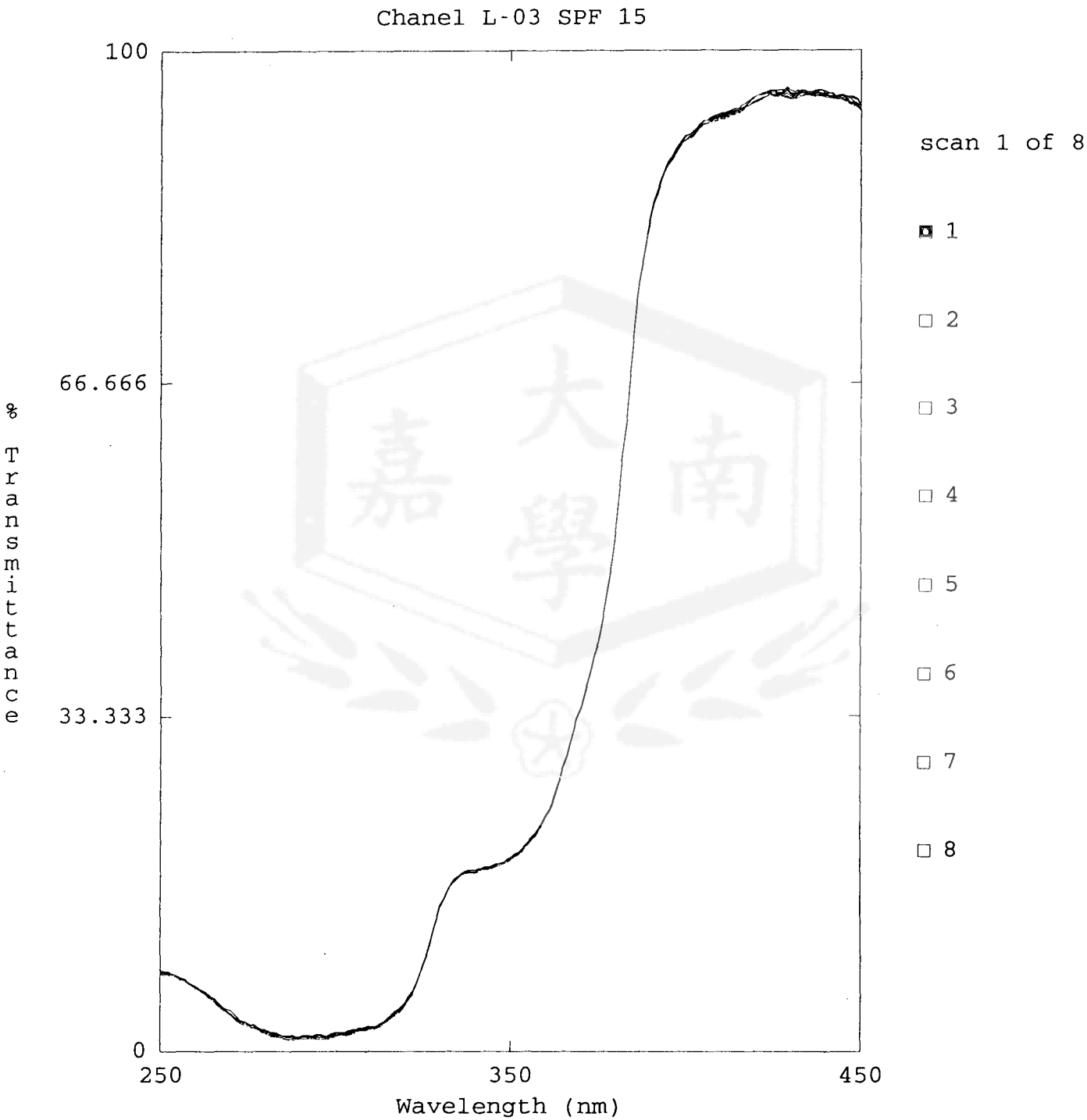
SPF Report

Sample: Chanel L-03 SPF 15
 Operator:
 Client:
 Comment:
 Date: 3 Feb 1999
 Time: 3:51 pm
 Wavelength Range: 290 - 400 nm

Units:	SPF	T(UVA)	T(UVB)
# of Scans:	8	8	8
Mean:	19.72%	34.78%	1.75%
STD:	0.46%	0.07%	0.12%
COV:	2.33%	0.19%	6.94%
UVA Ratio:	0.33		
Star Category:	*	MODERATE	

Scan #	SPF	Critical Wavelength	Scan #	SPF	Critical Wavelength
1	19.93	364 nm	7	19.47	364 nm
2	20.35	364 nm	8	19.14	364 nm
3	20.01	364 nm	9		
4	20.16	364 nm	10		
5	19.17	364 nm	11		
6	19.48	364 nm	12		

編號 16 防曬化粧品紫外線穿透圖譜



編號 17 防曬化粧品有效性分析

Labsphere Ultraviolet Transmittance Analyzer

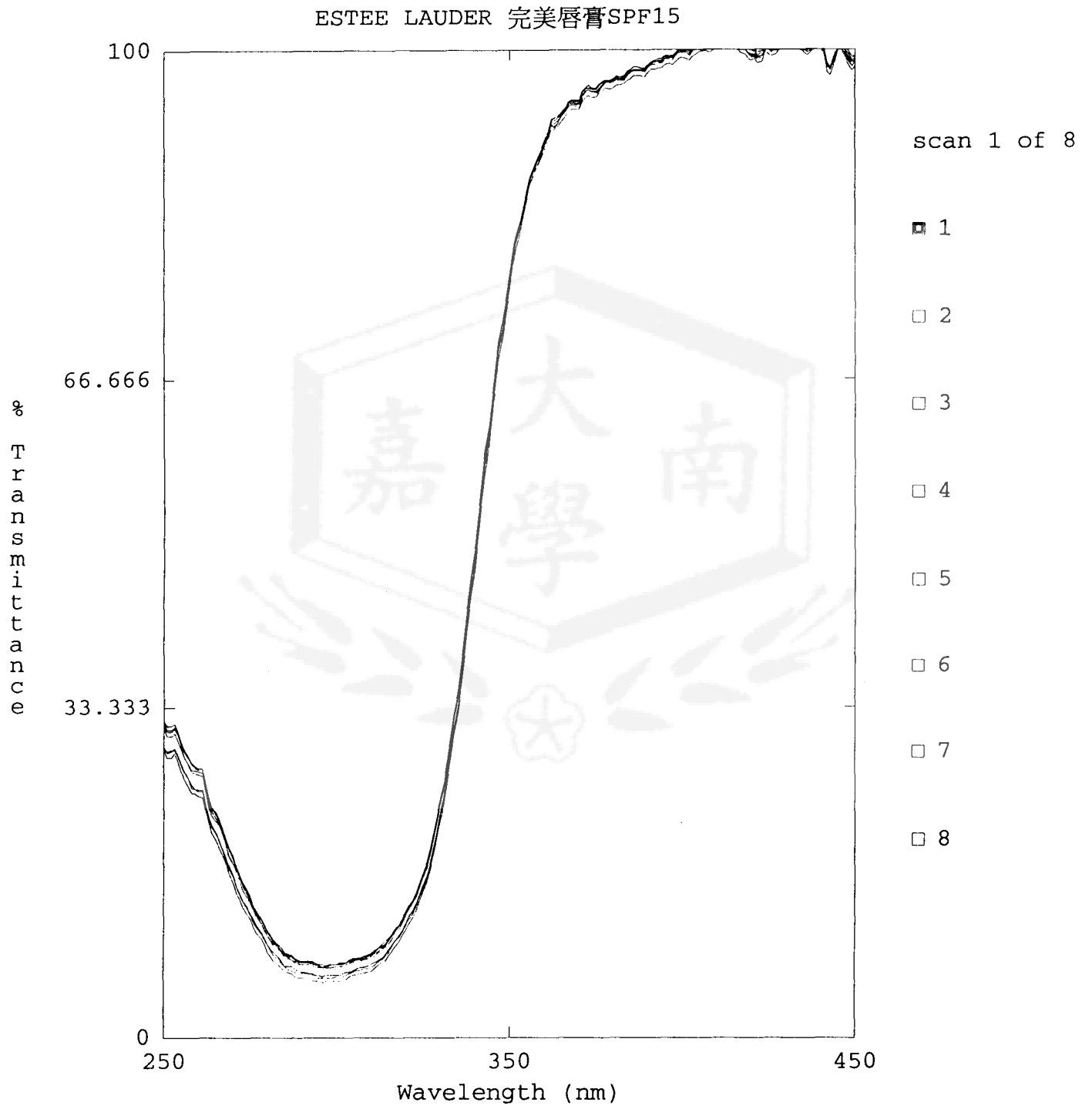
SPF Report

Sample: ESTEE LAUDER 完美唇膏SPF15
 Operator:
 Client:
 Comment:
 Date: 8 Feb 1999
 Time: 12:14 pm
 Wavelength Range: 290 - 400 nm

Units:	SPF	T(UVA)	T(UVB)
# of Scans:	8	8	8
Mean:	7.07%	69.33%	7.66%
STD:	0.33%	0.37%	0.69%
COV:	4.71%	0.53%	8.95%
UVA Ratio:	0.18		
Star Category:	-	Too low for a UVA claim	

Scan #	SPF	Critical Wavelength	Scan #	SPF	Critical Wavelength
1	6.87	336 nm	7	6.76	336 nm
2	6.80	336 nm	8	6.97	337 nm
3	6.81	336 nm	9		
4	7.64	336 nm	10		
5	7.41	336 nm	11		
6	7.30	336 nm	12		

編號 17 防曬化粧品紫外線穿透圖譜



編號 18 防曬化粧品有效性分析

Labsphere Ultraviolet Transmittance Analyzer

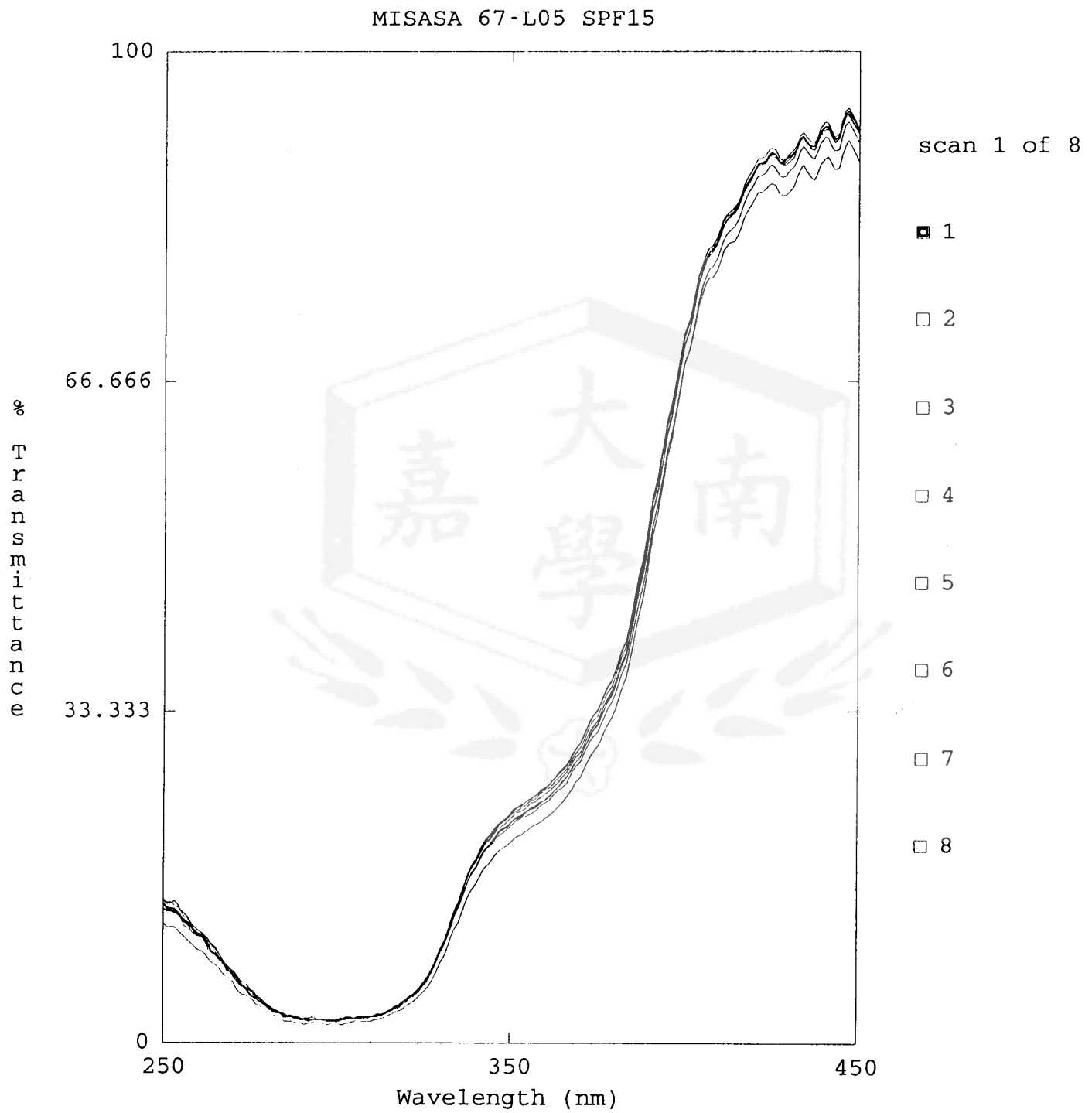
SPF Report

Sample: MISASA 67-L05 SPF15
 Operator:
 Client:
 Comment:
 Date: 4 Feb 1999
 Time: 3:56 pm
 Wavelength Range: 290 - 400 nm

Units:	SPF	T(UVA)	T(UVB)
# of Scans:	8	8	8
Mean:	20.58%	27.00%	2.56%
STD:	1.01%	0.89%	0.15%
COV:	4.90%	3.31%	5.91%
UVA Ratio:	0.40		
Star Category:	*	MODERATE	

Scan #	SPF	Critical Wavelength	Scan #	SPF	Critical Wavelength
1	23.00	373 nm	7	20.70	372 nm
2	20.34	373 nm	8	20.15	372 nm
3	19.97	372 nm	9		
4	20.39	372 nm	10		
5	20.10	372 nm	11		
6	19.97	372 nm	12		

編號 18 防曬化粧品紫外線穿透圖譜



編號 19 防曬化粧品有效性分析

Labsphere Ultraviolet Transmittance Analyzer

SPF Report

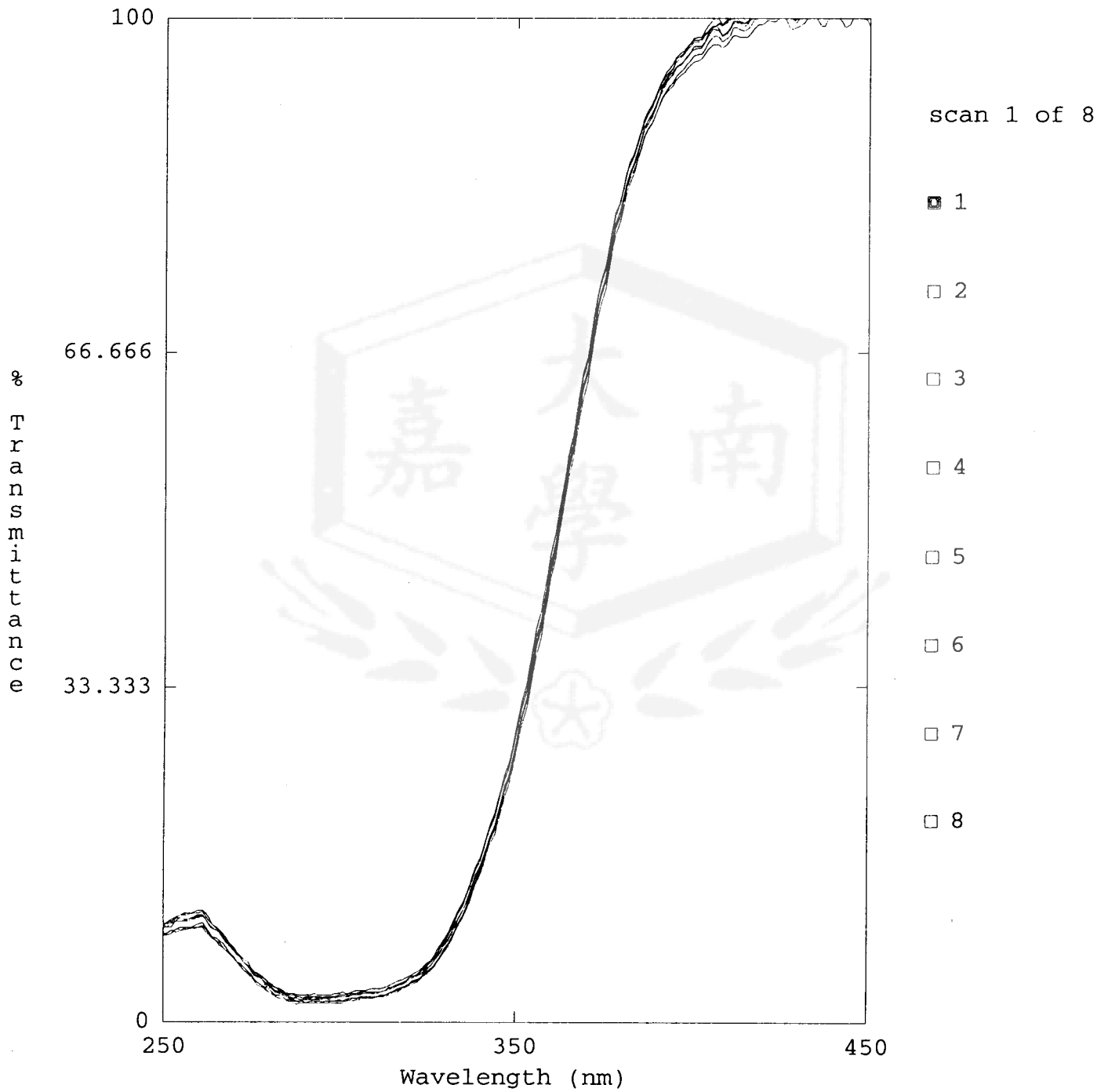
Sample: BODY SHOP 68-LO6 SPF15
 Operator:
 Client:
 Comment:
 Date: 4 Feb 1999
 Time: 4:10 pm
 Wavelength Range: 290 - 400 nm

Units:	SPF	T(UVA)	T(UVB)
# of Scans:	8	8	8
Mean:	16.05%	45.70%	2.53%
STD:	0.83%	0.60%	0.29%
COV:	5.19%	1.31%	11.58%
UVA Ratio:	0.30		
Star Category:	*	MODERATE	

Scan #	SPF	Critical Wavelength	Scan #	SPF	Critical Wavelength
1	15.41	351 nm	7	15.77	352 nm
2	15.56	352 nm	8	17.08	351 nm
3	17.07	352 nm	9		
4	16.82	351 nm	10		
5	14.87	352 nm	11		
6	15.86	352 nm	12		

編號 19 防曬化粧品紫外線穿透圖譜

BODY SHOP 68-LO6 SPF15



編號 20 防曬化粧品有效性分析

Labsphere Ultraviolet Transmittance Analyzer

SPF Report

Sample: 資生堂防曬護唇霜SPF15

Operator:

Client:

Comment:

Date: 8 Feb 1999

Time: 3:16 pm

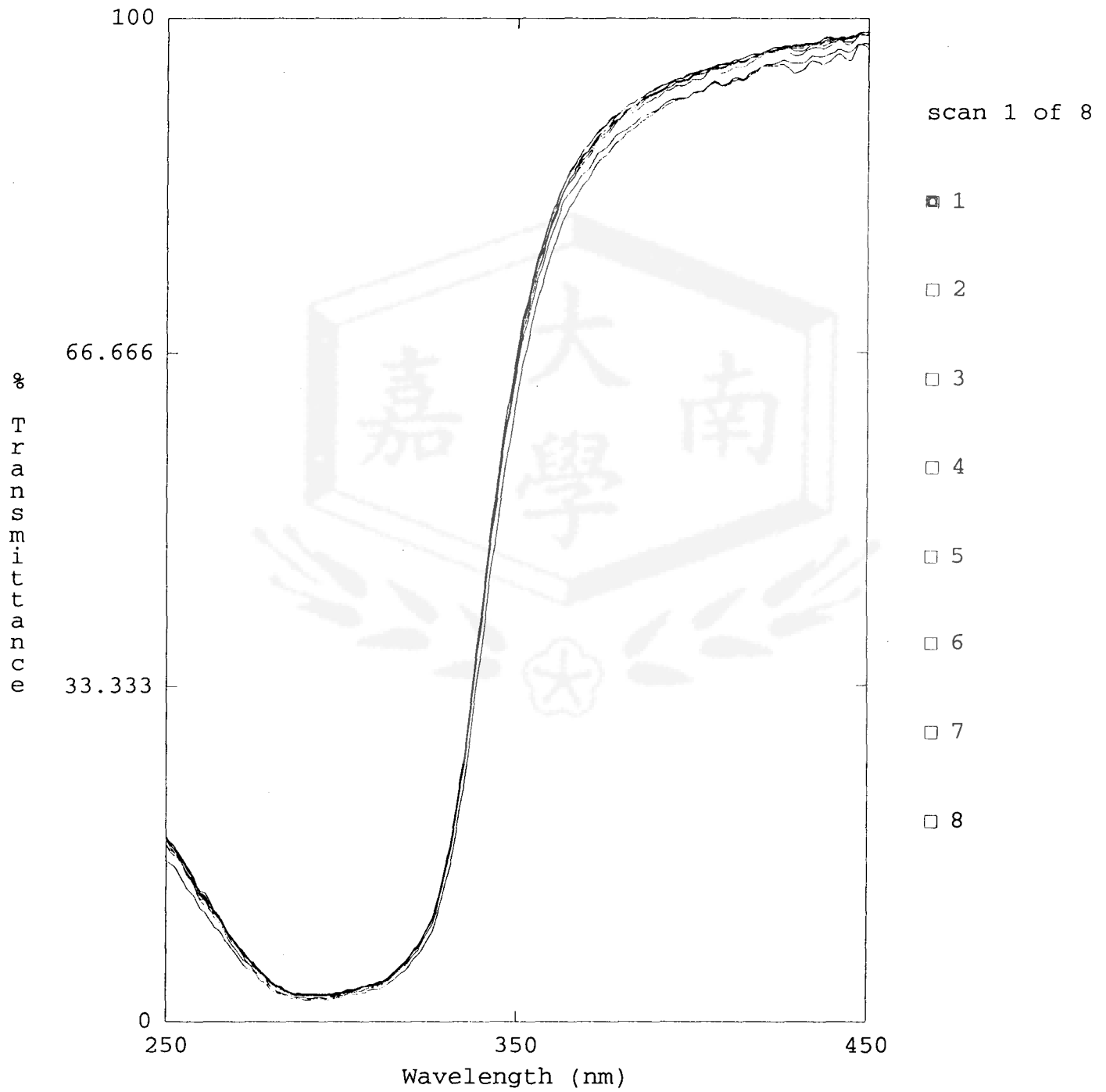
Wavelength Range: 290 - 400 nm

Units:	SPF	T(UVA)	T(UVB)
# of Scans:	8	8	8
Mean:	10.73%	61.19%	3.14%
STD:	0.35%	0.95%	0.20%
COV:	3.23%	1.55%	6.31%
UVA Ratio:	0.19		
Star Category:	-	Too low for a UVA claim	

Scan #	SPF	Critical Wavelength	Scan #	SPF	Critical Wavelength
1	10.66	339 nm	7	10.63	340 nm
2	10.43	339 nm	8	10.53	339 nm
3	10.50	339 nm	9		
4	10.68	340 nm	10		
5	11.51	341 nm	11		
6	10.91	339 nm	12		

編號 20 防曬化粧品紫外線穿透圖譜

資生堂防曬護唇霜SPF15



編號 21 防曬化粧品有效性分析

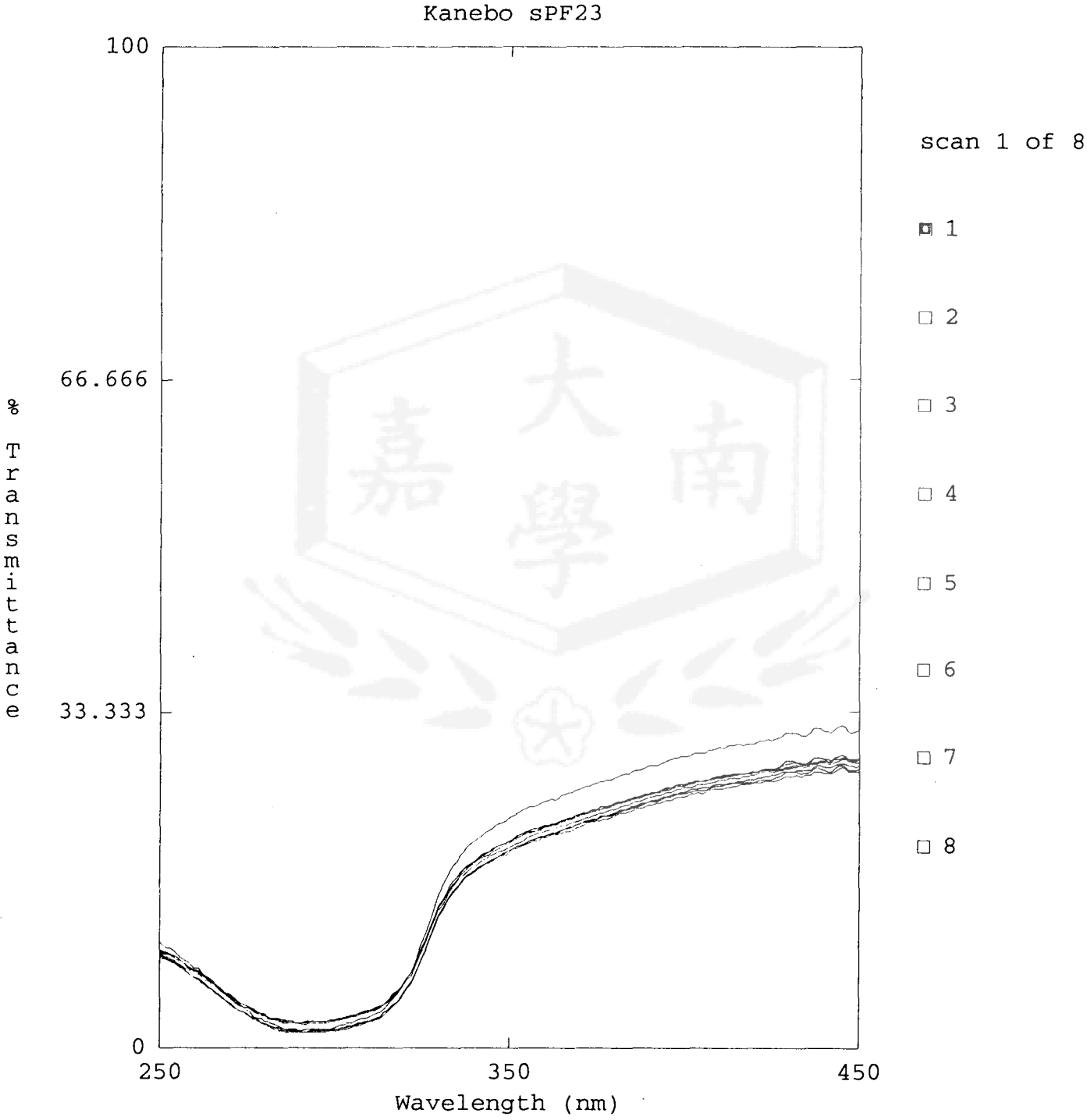
Labsphere Ultraviolet Transmittance Analyzer

SPF Report

Sample: Kanebo SPF23
 Operator:
 Client:
 Comment:
 Date: 3 Feb 1999
 Time: 11:16 am
 Wavelength Range: 290 - 400 nm
 Units: SPF T(UVA) T(UVB)
 # of Scans: 8 8 8
 Mean: 19.91% 19.41% 2.56%
 STD: 1.99% 0.99% 0.47%
 COV: 10.01% 5.09% 18.33%
 UVA Ratio: 0.46
 Star Category: ** GOOD

Scan #	SPF	Critical Wavelength	Scan #	SPF	Critical Wavelength
1	21.94	383 nm	7	18.06	384 nm
2	22.72	383 nm	8	19.10	382 nm
3	22.16	383 nm	9		
4	18.68	384 nm	10		
5	18.25	384 nm	11		
6	18.38	384 nm	12		

編號 21 防曬化粧品紫外線穿透圖譜



編號 22 防曬化粧品有效性分析

Labsphere Ultraviolet Transmittance Analyzer SPF Report

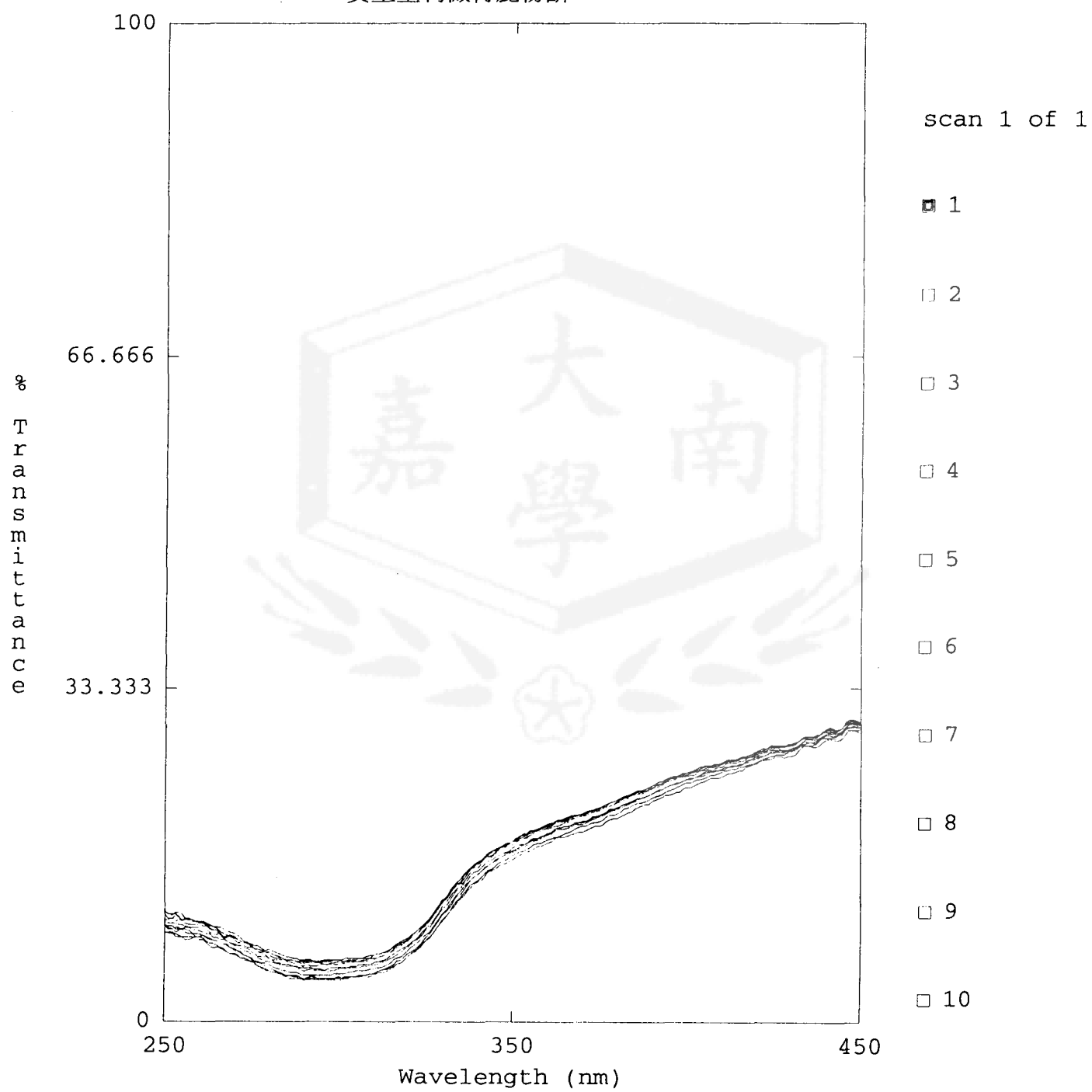
Sample: 資生堂莉薇特麗粉餅AM10
 Operator:
 Client:
 Comment:
 Date: 2 Mar 1999
 Time: 10:41 am
 Wavelength Range: 290 - 400 nm

Units:	SPF	T(UVA)	T(UVB)
# of Scans:	10	10	10
Mean:	14.49%	17.33%	5.48%
STD:	1.58%	0.65%	0.75%
COV:	10.88%	3.76%	13.63%
UVA Ratio:	0.61		
Star Category:	***	SUPERIOR	

Scan #	SPF	Critical Wavelength	Scan #	SPF	Critical Wavelength
1	14.35	385 nm	7	16.75	384 nm
2	12.65	385 nm	8	15.23	385 nm
3	16.22	385 nm	9	13.96	385 nm
4	13.30	385 nm	10	13.13	385 nm
5	12.83	385 nm	11		
6	16.49	385 nm	12		

編號 22 防曬化粧品紫外線穿透圖譜

資生堂莉薇特麗粉餅AM10



編號 23 防曬化粧品有效性分析

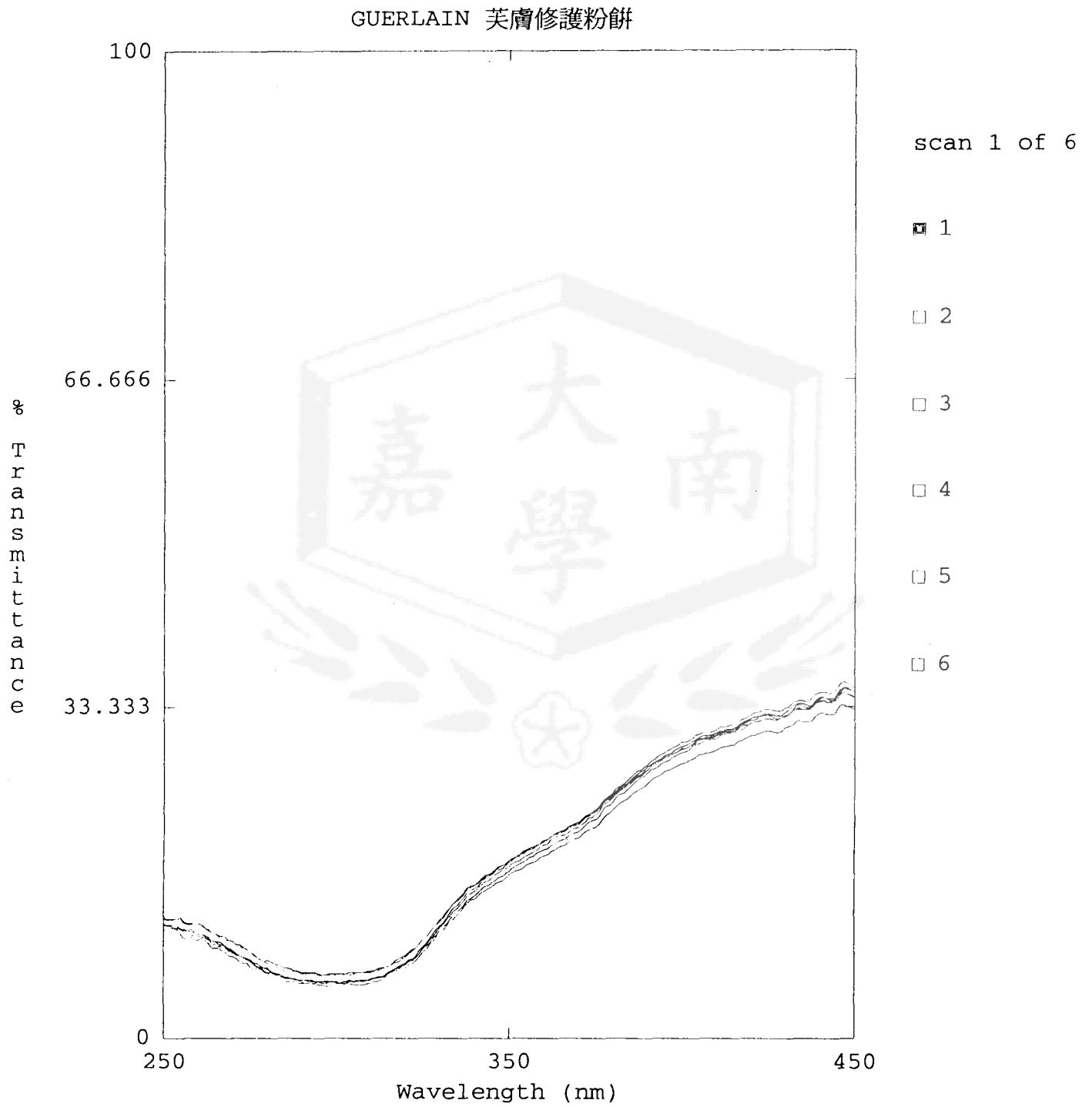
Labsphere Ultraviolet Transmittance Analyzer

SPF Report

Sample: GUERLAIN 芙膚修護粉餅
 Operator:
 Client:
 Comment:
 Date: 4 Feb 1999
 Time: 2:51 pm
 Wavelength Range: 290 - 400 nm
 Units: SPF T(UVA) T(UVB)
 # of Scans: 6 6 6
 Mean: 13.45% 18.50% 6.16%
 STD: 0.83% 0.56% 0.47%
 COV: 6.16% 3.05% 7.60%
 UVA Ratio: 0.61
 Star Category: *** SUPERIOR

Scan #	SPF	Critical Wavelength	Scan #	SPF	Critical Wavelength
1	13.86	384 nm	7		
2	12.35	384 nm	8		
3	12.56	384 nm	9		
4	14.50	384 nm	10		
5	13.63	383 nm	11		
6	13.82	383 nm	12		

編號 23 防曬化粧品紫外線穿透圖譜



編號 24 防曬化粧品有效性分析

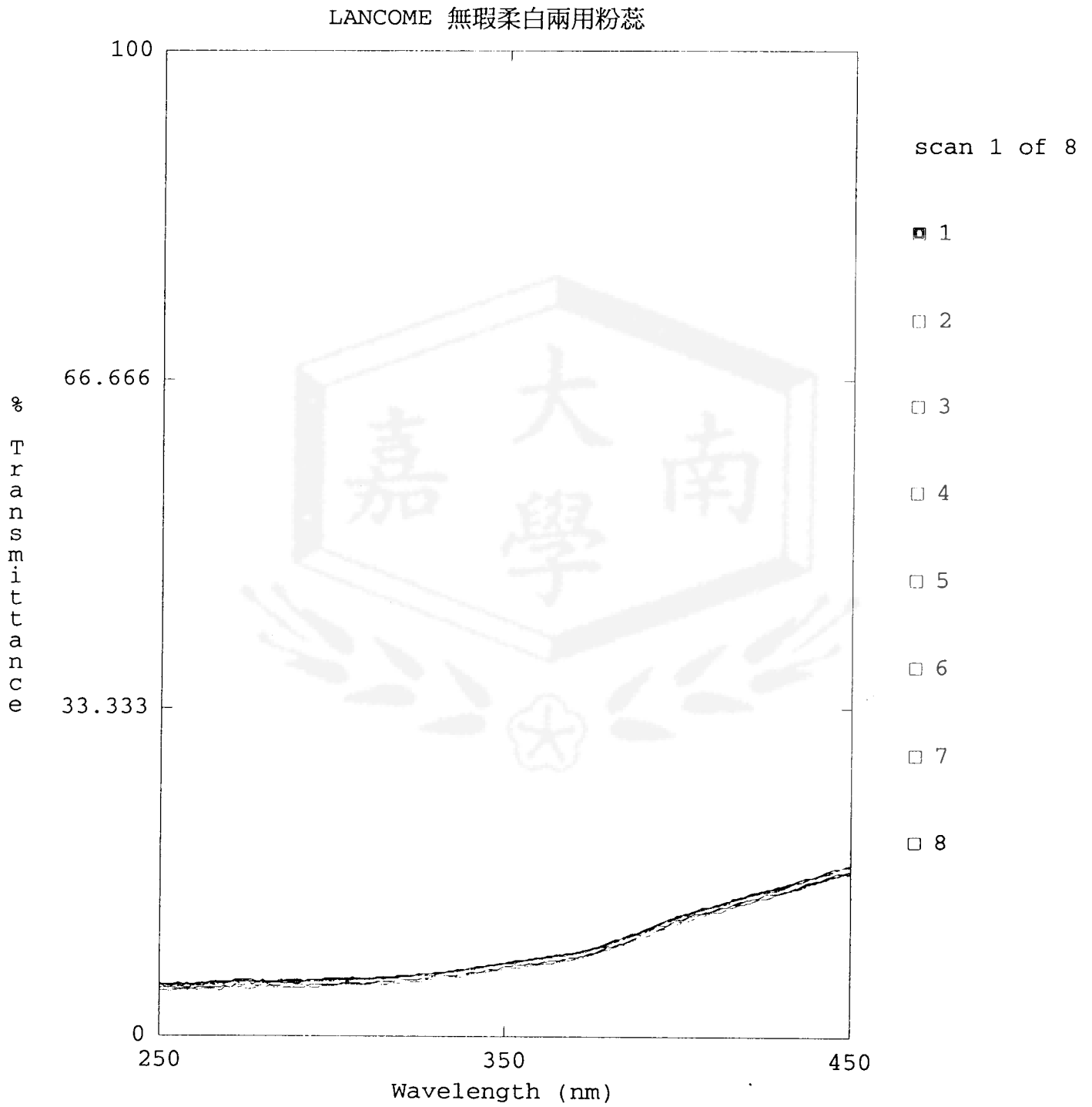
Labsphere Ultraviolet Transmittance Analyzer SPF Report

Sample: LANCOME 無瑕柔白兩用粉蕊
 Operator:
 Client:
 Comment:
 Date: 8 Feb 1999
 Time: 3:21 pm
 Wavelength Range: 290 - 400 nm

Units:	SPF	T(UVA)	T(UVB)
# of Scans:	8	8	8
Mean:	17.02%	8.02%	5.55%
STD:	0.72%	0.25%	0.24%
COV:	4.22%	3.16%	4.30%
UVA Ratio:	0.88		
Star Category:	****	MAXIMUM	

Scan #	SPF	Critical Wavelength	Scan #	SPF	Critical Wavelength
1	16.82	387 nm	7	16.66	387 nm
2	16.62	387 nm	8	16.85	387 nm
3	17.86	387 nm	9		
4	18.40	387 nm	10		
5	16.54	387 nm	11		
6	16.39	387 nm	12		

編號 24 防曬化粧品紫外線穿透圖譜



編號 25 防曬化粧品有效性分析

Labsphere Ultraviolet Transmittance Analyzer SPF Report

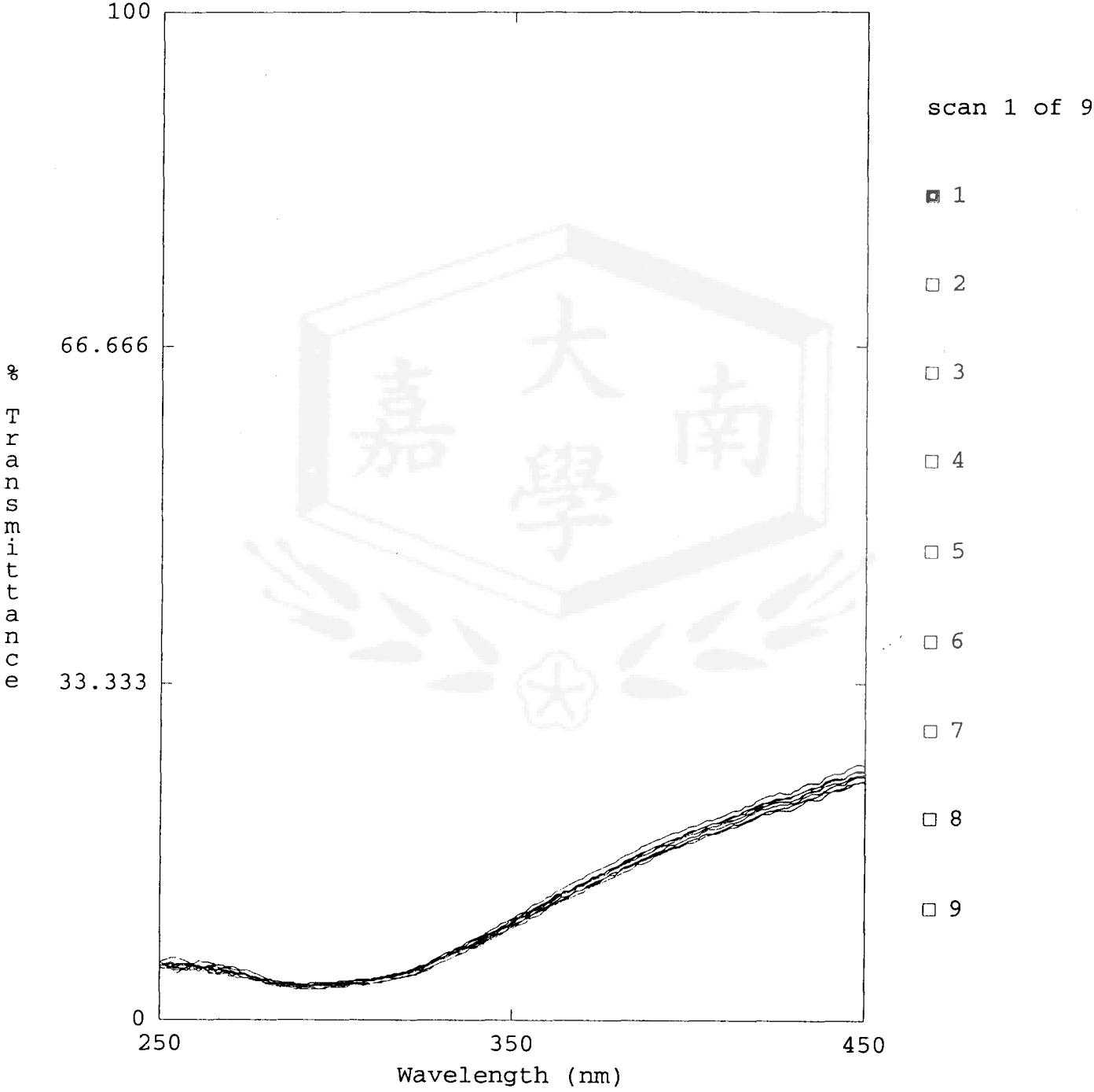
Sample: 迪奧美白兩用粉餅SPF20
 Operator:
 Client:
 Comment:
 Date: 8 Feb 1999
 Time: 3:42 pm
 Wavelength Range: 290 - 400 nm

Units:	SPF	T(UVA)	T(UVB)
# of Scans:	9	9	9
Mean:	22.10%	11.02%	3.63%
STD:	0.88%	0.33%	0.16%
COV:	3.98%	3.00%	4.41%
UVA Ratio:	0.68		
Star Category:	***	SUPERIOR	

Scan #	SPF	Critical Wavelength	Scan #	SPF	Critical Wavelength
1	21.95	385 nm	7	21.88	385 nm
2	21.58	385 nm	8	23.32	385 nm
3	23.74	385 nm	9	22.20	385 nm
4	21.41	385 nm	10		
5	21.06	385 nm	11		
6	21.78	385 nm	12		

編號 25 防曬化粧品紫外線穿透圖譜

迪奧美白兩用粉餅SPF20



編號 26 防曬化粧品有效性分析

Labsphere Ultraviolet Transmittance Analyzer

SPF Report

Sample: 高絲粉餅
 Operator:
 Client:
 Comment:
 Date: 29 Apr 1999
 Time: 12:01 pm
 Wavelength Range: 290 - 400 nm
 Units: SPF T(UVA) T(UVB)
 # of Scans: 6 6 6
 Mean: 20.26% 7.11% 5.61%
 STD: 4.65% 1.68% 1.28%
 COV: 22.94% 23.57% 22.81%
 UVA Ratio: 0.89
 Star Category: **** MAXIMUM

Scan #	SPF	Critical Wavelength	Scan #	SPF	Critical Wavelength
1	17.10	388 nm	7		
2	20.24	388 nm	8		
3	13.55	387 nm	9		
4	23.36	388 nm	10		
5	20.46	388 nm	11		
6	26.85	388 nm	12		

編號 26 防曬化粧品紫外線穿透圖譜

高絲粉餅

