平面顯示技術概論

背光模組之設計與趨勢

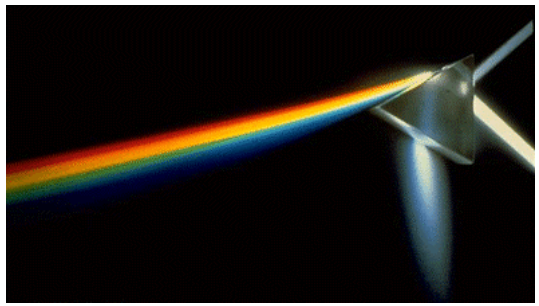
主講人： 潘重德 博士（輔祥實業股份有限公司）

講授日期： 2005年 11月 30日

Copy Rights Reserved © 2005

課 程 大 綱

- 背光模組的角色及功能
- 光源與色彩
- 背光模組的組成與光學
- 背光模組的規格與量測
- 背光模組的發展及挑戰
- Q & A

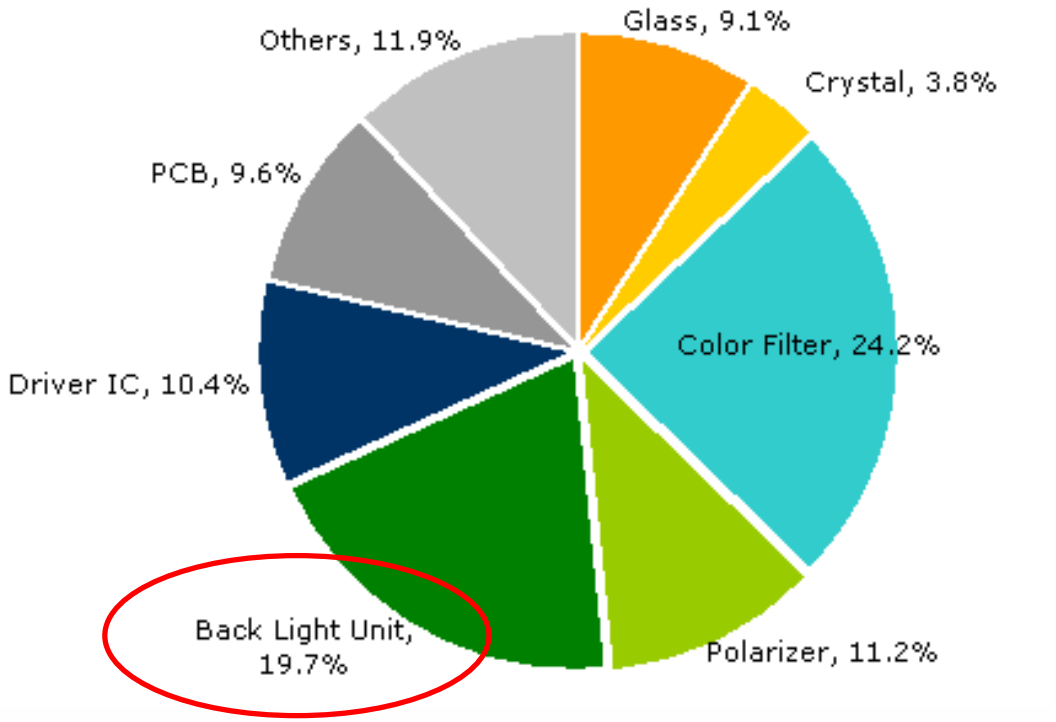


Copy Rights Reserved © 2005

LCD Key Components

17" LCM cost breakdown USD $150

(2004 Q4)



37" TV LCM USD $700

BLU	46.9%
CF	23.2%
Polarizer	9.4%
Glass	6.5%
Driver IC	3%
Liquid Crystal	3%

Note: BLU Include Inverter

資料來源：

Copy Rights Reserved © 2005

背光模組的應用與設計要求

- **Monitor / TV** — 高輝度、廣視角、大型化。
- **Notebook PC** — 高效率/省電化、輕薄化。
- 衛星導航/車載裝置 — 高輝度、堅固性、耐候性。
- 掌上型裝置 — 小尺寸、輕薄化、省電化。

產品應用範圍

DV液晶螢幕

車上型液晶螢幕

PDA螢幕

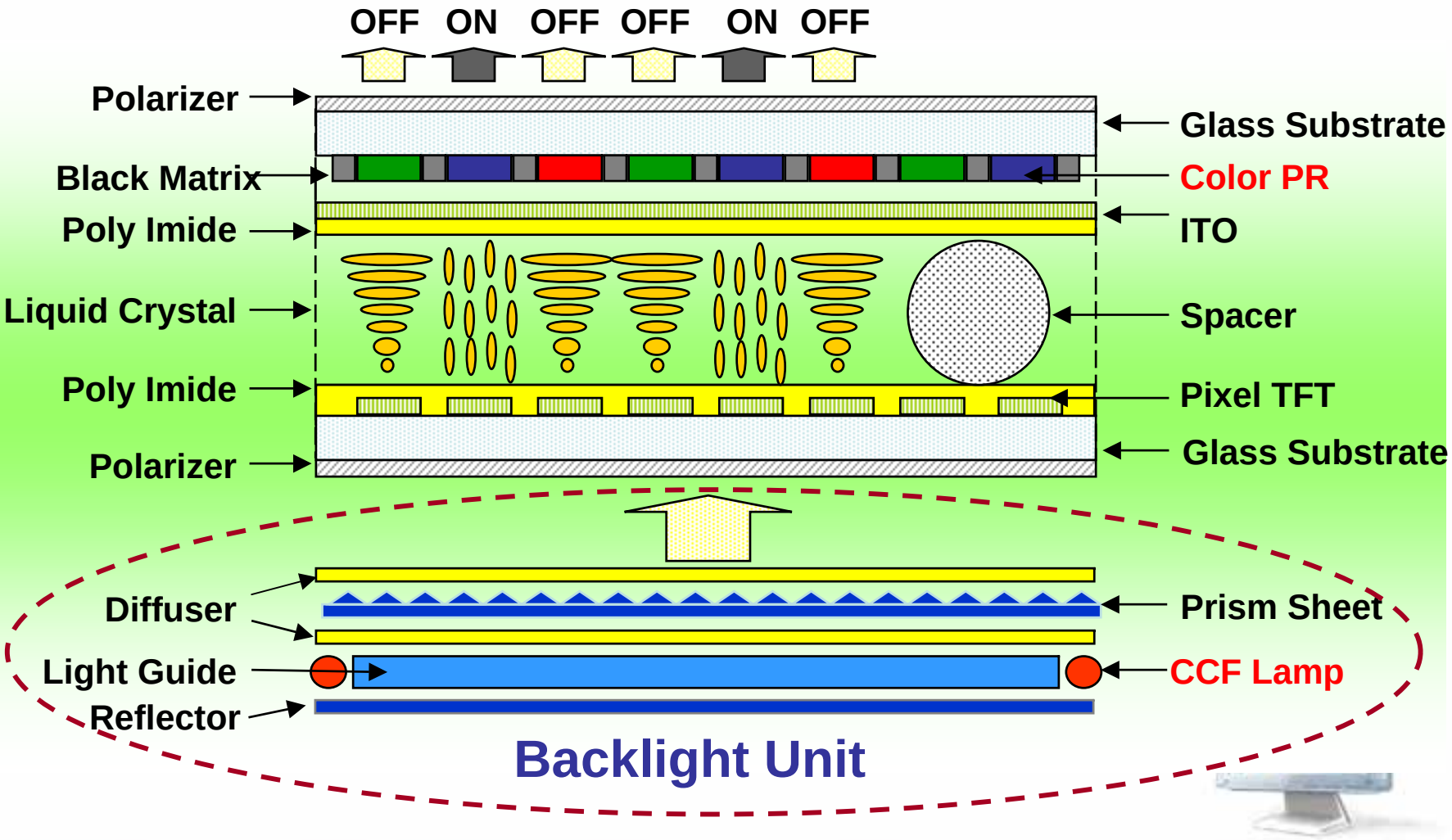
手機螢幕

電視液晶螢幕

筆記型電腦液晶螢幕

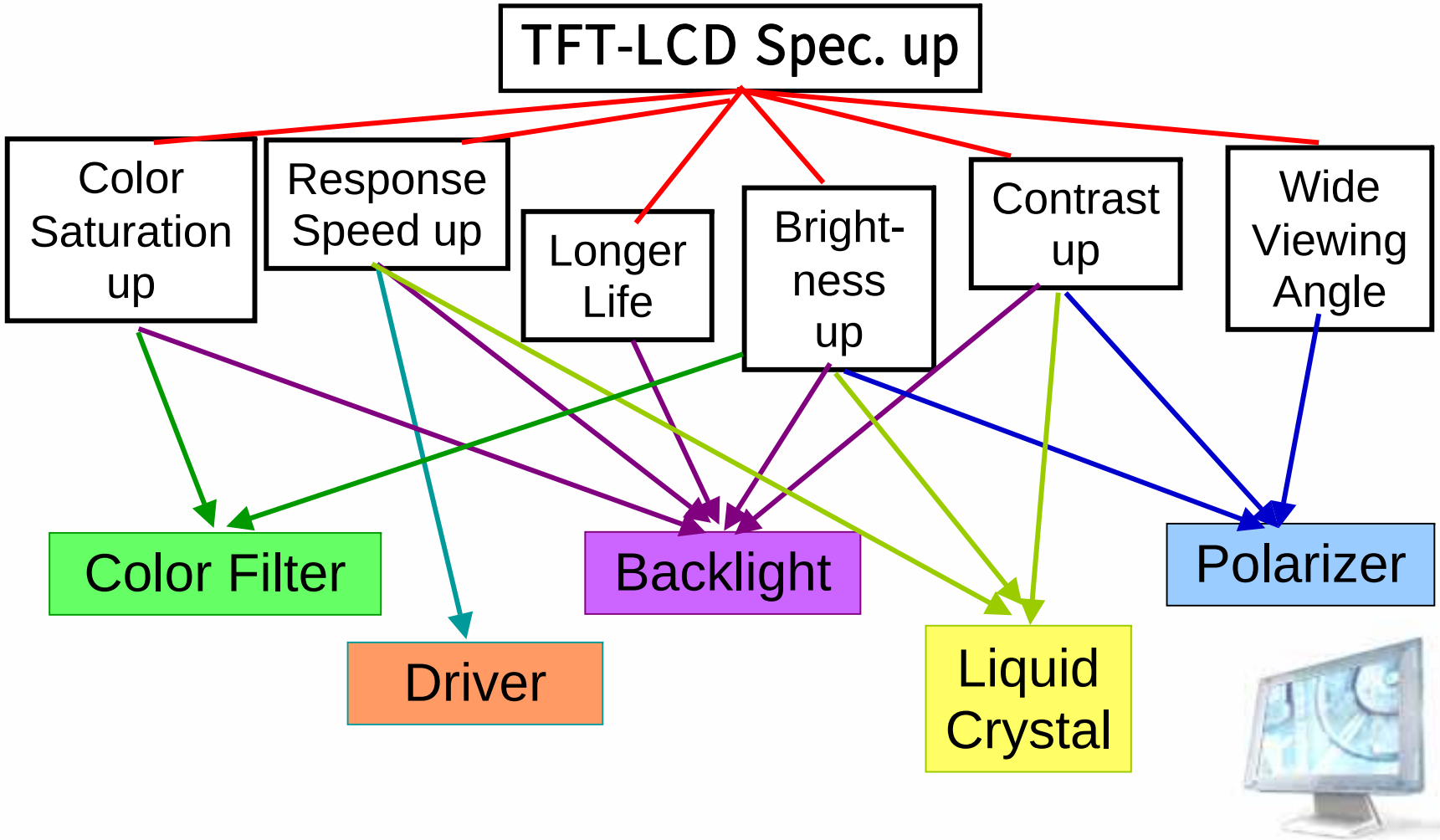
Copy Rights Reserved © 2005

TFT LCD Structure



Copy Rights Reserved © 2005

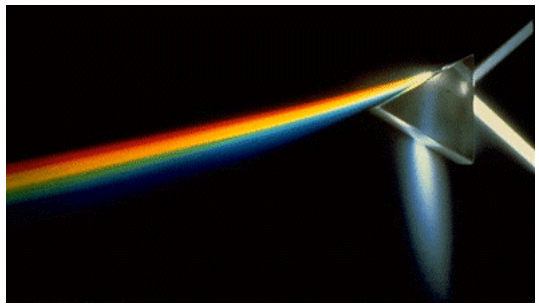
Key Component Technologies for TFT LCD



Copy Rights Reserved © 2005

課程大綱

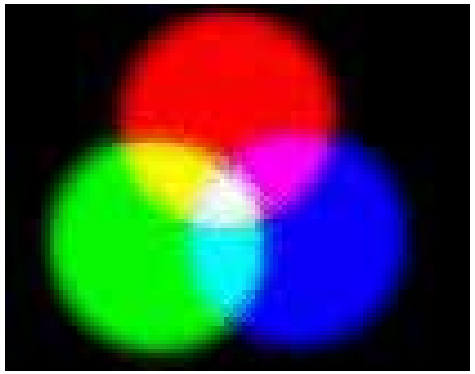
- 背光模組的角色及功能
- 光源與色彩
- 背光模組的組成與光學
- 背光模組的規格與量測
- 背光模組的發展及挑戰
- Q & A



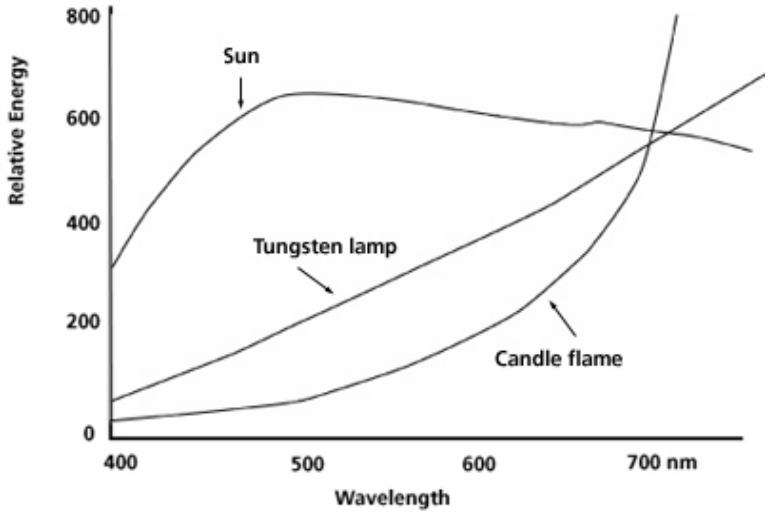
Copy Rights Reserved © 2005

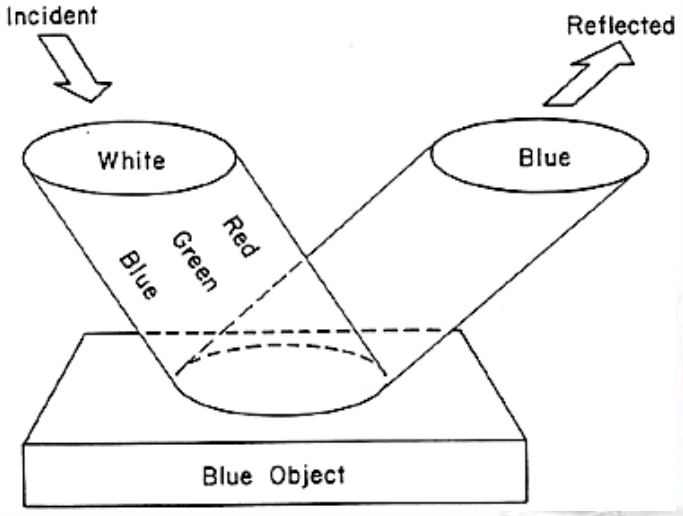
光源色 與 物體色

❖ 光源色：加法混色



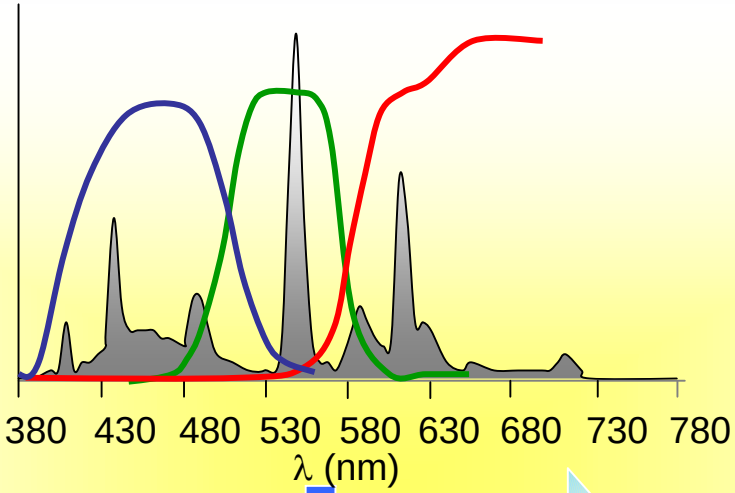
❖ 物體色：減法混色





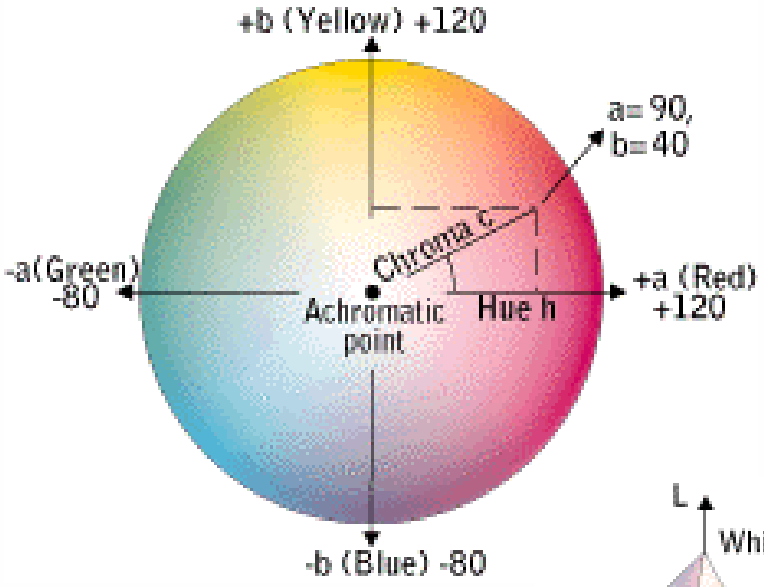
Copy Rights Reserved © 2005

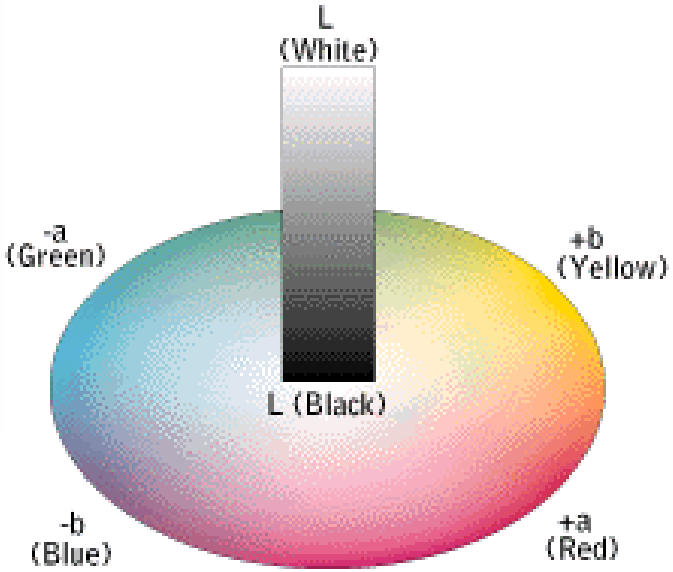
LCD Color Image

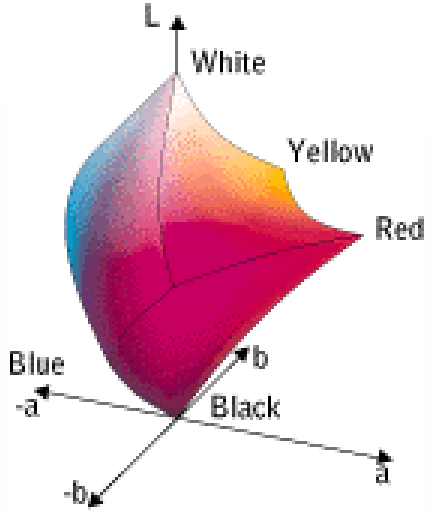


Copy Rights Reserved © 2005

Munsell 表色系統







- 色相：圓週方向
- 彩度：半徑方向

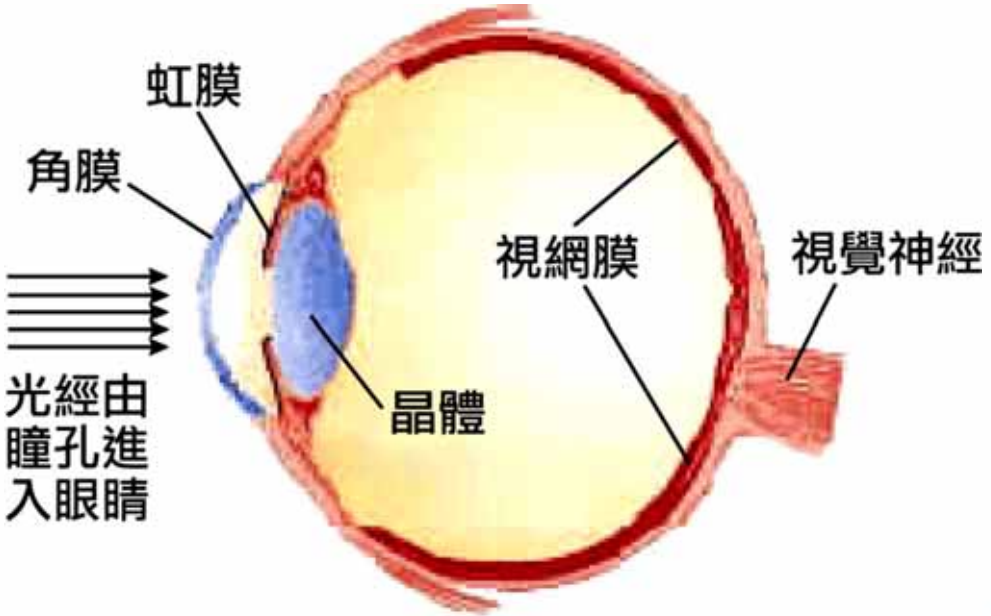
- 明度：上下方向

Copy Rights Reserved © 2005

人 眼 的 視 覺

視網膜上的感光細胞：

- 柱狀細胞—對光的強弱靈敏度很高。
- 錐狀細胞—靈敏度較低，但辨色能力極好。
- 人眼對綠光的靈敏度最高，對紅光的靈敏度較低。



Copy Rights Reserved © 2005

CIE *R G B* 表色系統

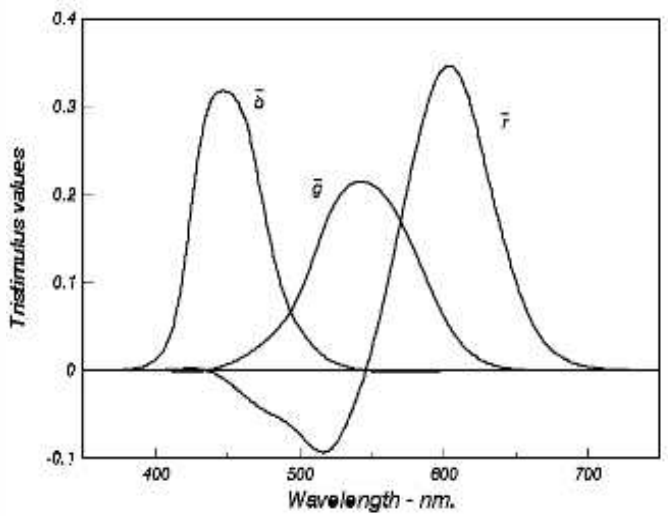
三基色：紅光 (R)	λ = 700.0 nm	1	流明
綠光 (G)	λ = 546.1 nm	4.5907	流明
藍光 (B)	λ = 435.8 nm	0.0601	流明
標準白光	混光	5.6508	流明

r-q-b 色度空間：

$$r = R/(R+G+B)$$

$$q = G/(R+G+B)$$

$$b = B/(R+G+B) = 1 - (r + q)$$



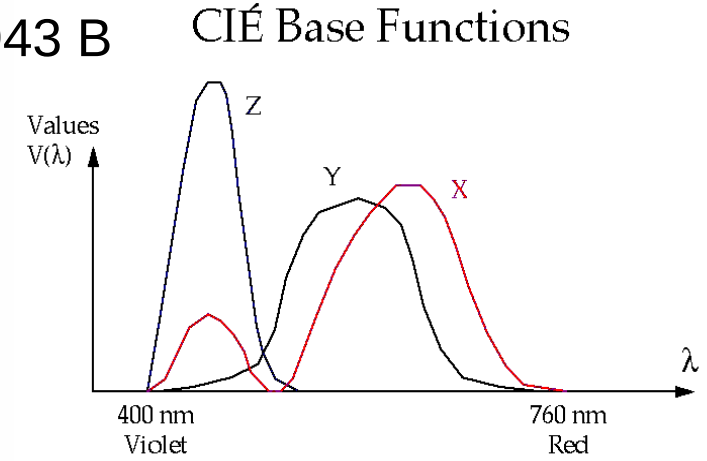
Copy Rights Reserved © 2005

CIE *XYZ* 表色系統

- **CIE： Commission Internationale de l'Eclairage**
  國際照明委員會
- **1931 年標準**：用XYZ三標準色刺激值(色量)來定義所有可見色，並使所有混色係數爲正值。

$$X = 2.7689\,R + 1.7517\,G + 1.1302\,B$$
$$Y = 1.0000\,R + 4.5907\,G + 0.0601\,B$$
$$Z = 0.0000\,R + 0.0565\,G + 5.5943\,B$$

- Y = 輝度 (nit)
- X = Y = Z：等量白光
- (x, y) 座標系統 ＝ 色度



Copy Rights Reserved © 2005

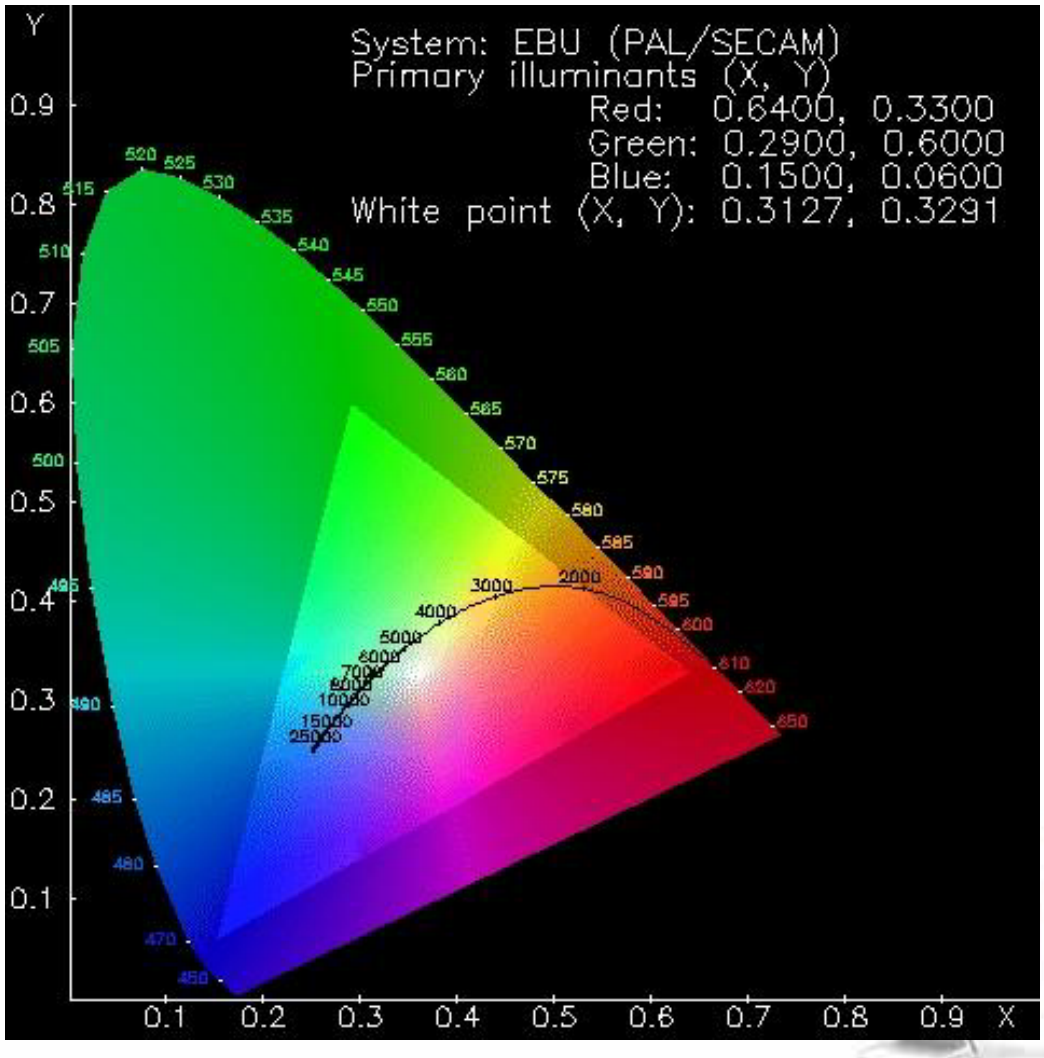
CIE1931 x y 色度座標

$$x = \frac{X}{X+Y+Z}$$

$$y = \frac{Y}{X+Y+Z}$$

$$z = \frac{Z}{X+Y+Z}$$

$$x + y + z = 1$$



Copy Rights Reserved © 2005

CIE 1931 以後的發展

- CIE 1931：以 2° 視野爲基礎，可應用至 4° 視野。
- CIE 1964 $X_{10}Y_{10}Z_{10}$ 輔助表色系統：10° 視野。
- CIE 1960 "UCS" 色度座標：色差程度在 (u, v) 色度座標上爲等距離。

$$u = \frac{4X}{X + 15Y + 3Z} = \frac{2x}{-x + 6y + 1.5}$$

$$v = \frac{6Y}{X + 15Y + 3Z} = \frac{3y}{-x + 6y + 1.5}$$

- CIE 1976 L * u* v* 表色系統：UCS色度座標 (u', v')

  (u', v') = (u, 1.5 v)

- CIE 1976 L * a* b* 表色系統：色差程度爲等距離，且爲直角座標。

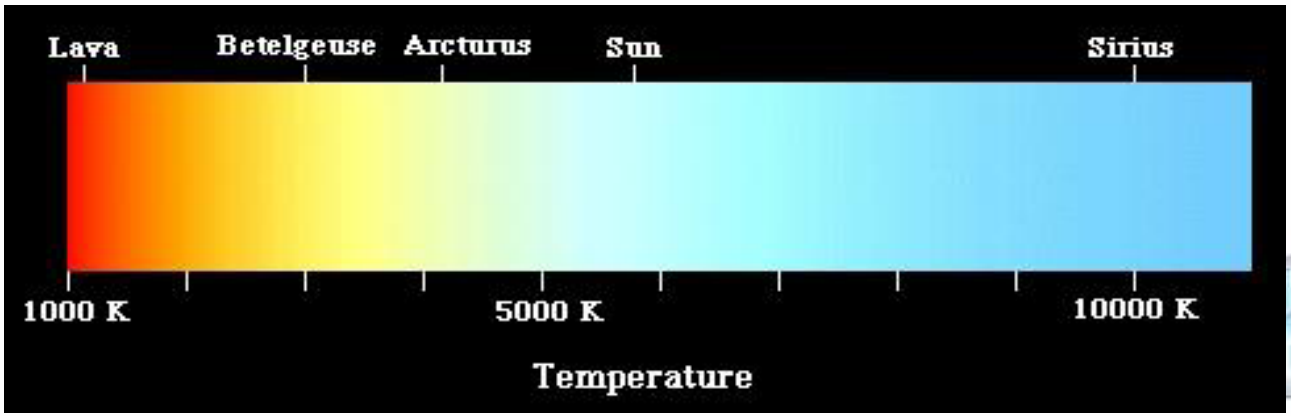
Copy Rights Reserved © 2005

黑體輻射 與 色溫

- 黑體輻射出度：

$$M = \sigma T^4 \qquad \text{where 輻射常數 } \sigma = 5.67x10^{-8}$$

- 色溫：當光源色與黑體在某溫度下的輻射顏色相同時即稱爲該光源的色溫。
- 當光源之光譜分不與黑體輻射相去太遠時即不適合用色溫來描述該光源顏色。



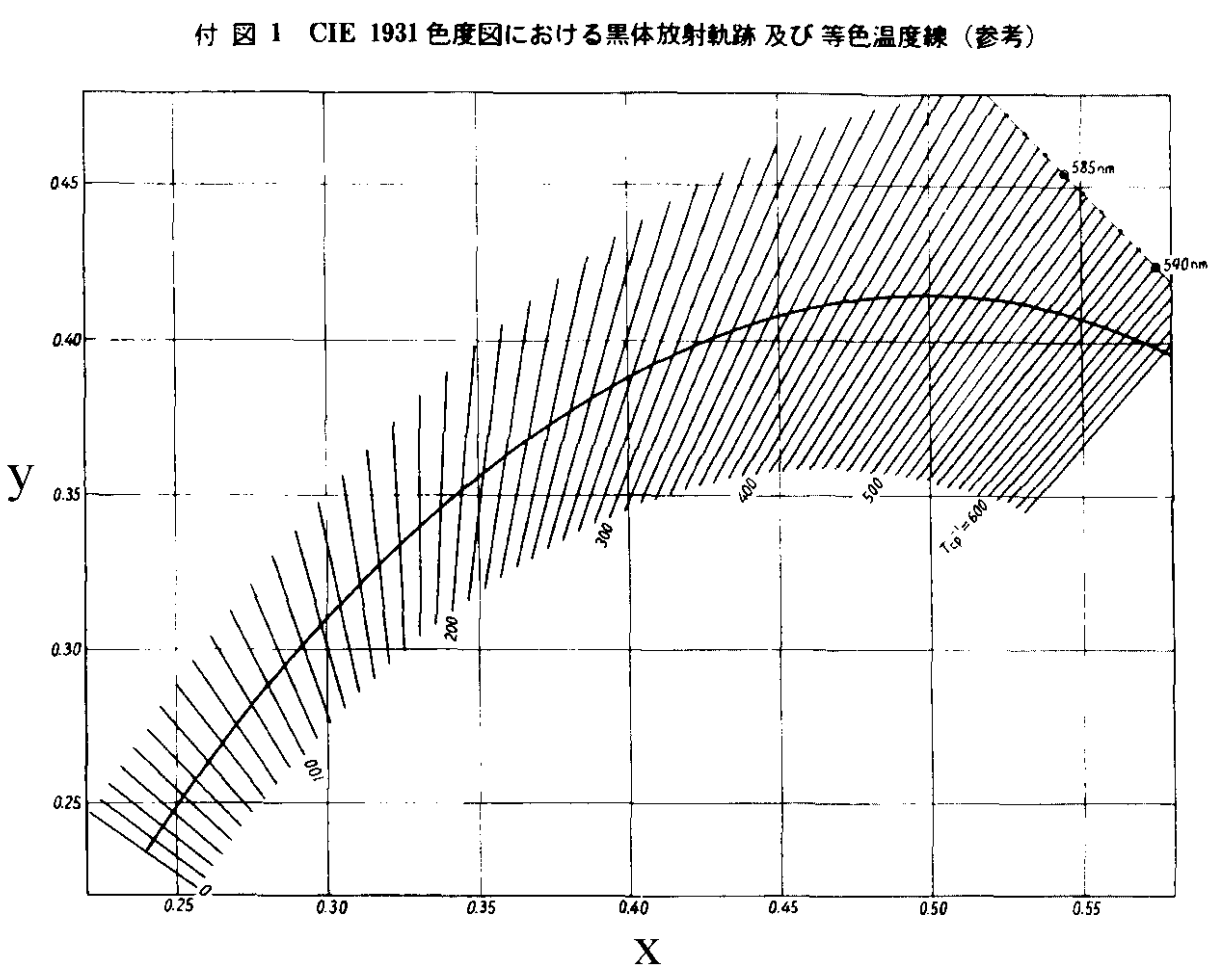
Copy Rights Reserved © 2005

黑體輻射軌跡

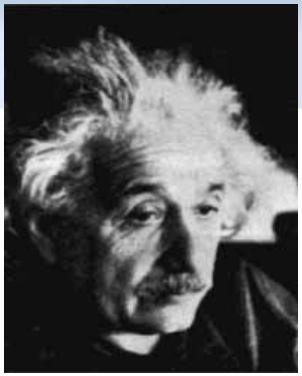
Tc = 437 n^3
+ 3601 n^2
+ 6830 n
+ 5517

Where

$$n = \frac{x - 0.3320}{0.1858 - y}$$



Copy Rights Reserved © 2005



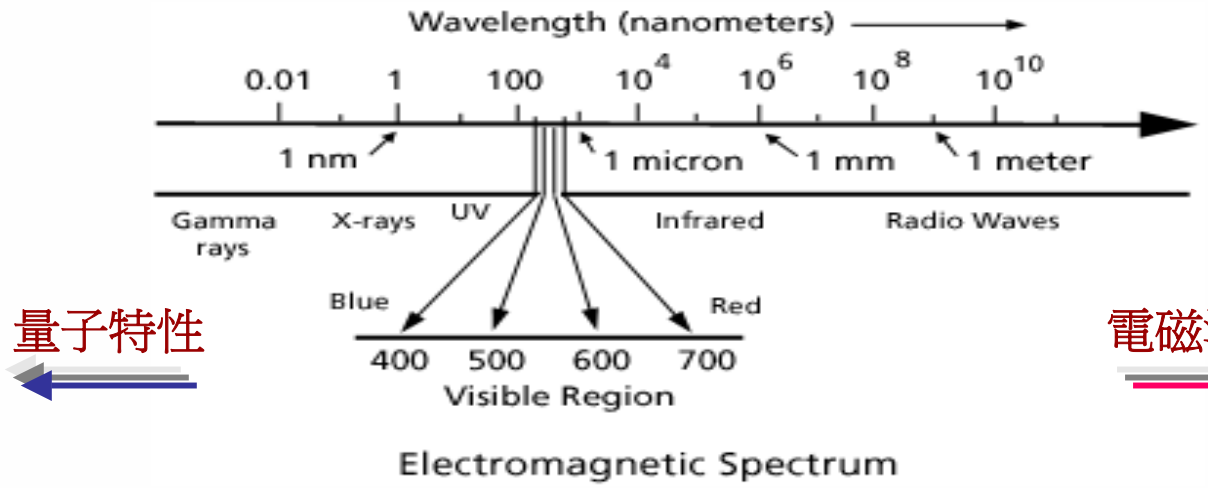
什麼是光？

- Newton：光是微粒子流束。 -*光可以轉彎嗎？*
  (1642-1727)
- Huygens：光是一種波動 。 -*可不經界質傳遞？*
  (1629-1695)
- Young：證實光的干涉現象存在。 -*粒子無法相減！*
  (1773-1829)
- Maxwell：光是一種電磁波。 $c = 3\ X\ 10^8\ m/s$
  (1831-1879)
- Hertz：證實光具有電磁波特性。 -*如何解釋光電效應？*
  (1857-1894)
- Planck：量子論探討微觀世界。 -*解釋黑體輻射、光電效應。*
  (1858-1947)
- Einstein：相對論解釋光電效應。 $E = hf$
  (1879-1955)

Copy Rights Reserved © 2005

電磁波論 與 量子論 相輔相成

- 電磁波理論：圓滿解釋光的傳遞與干涉現象。
- 量子理論：成功解釋光子 (*Photon*)[註] 如何激發電子的現象（*光電效應*）。

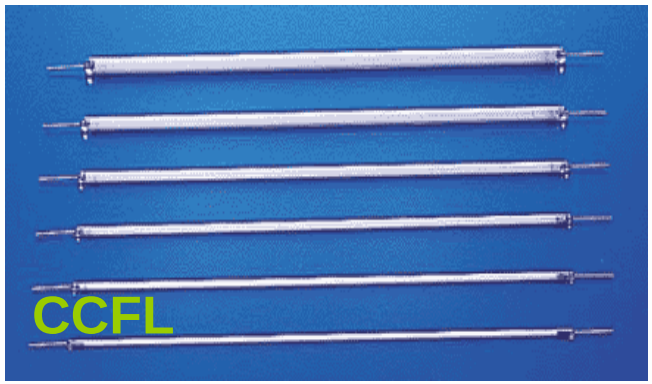


Electromagnetic Spectrum

註：*Photon 沒有質量。*

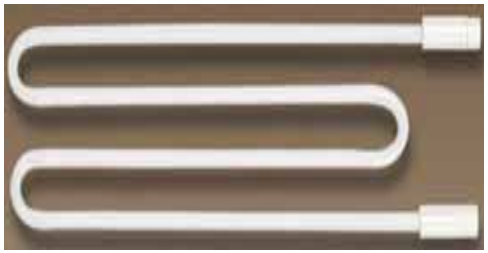
Copy Rights Reserved © 2005

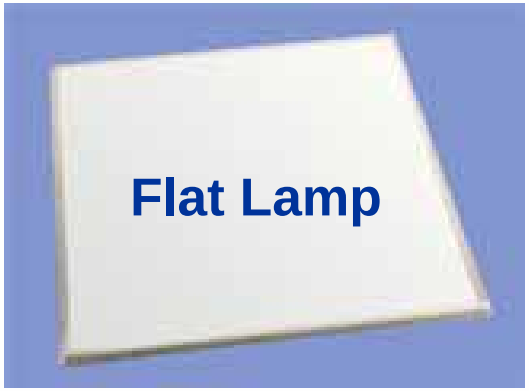
Competing Lighting Technologies



LED

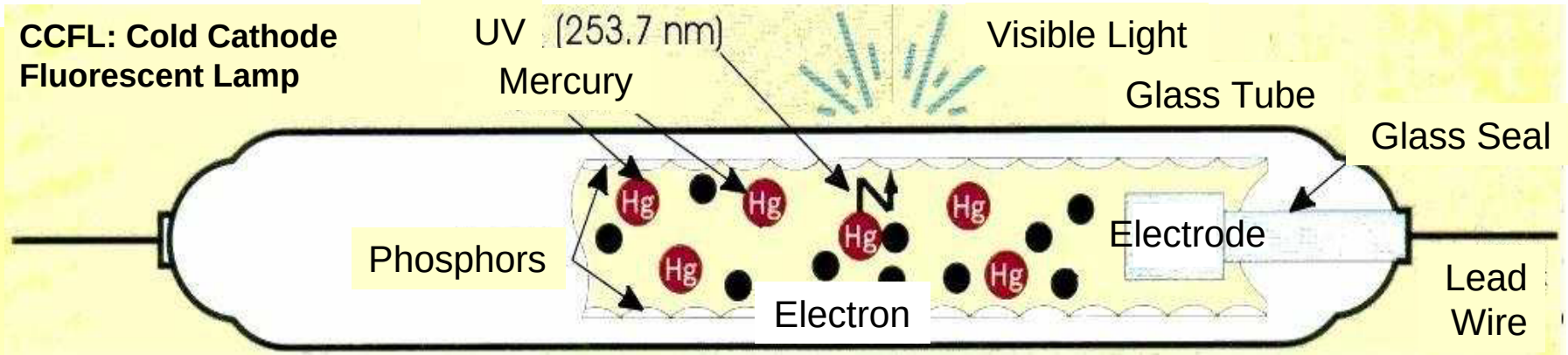
EEFL





Copy Rights Reserved © 2005

Lighting and Spectrum -- CCFLs

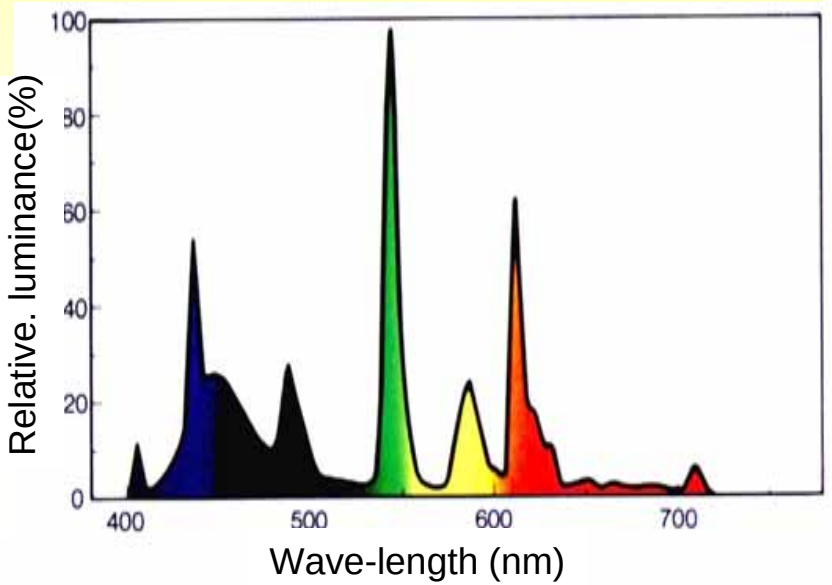


電壓 —電極表面受激發→ 電子束

—碰撞→ 水銀原子 —離子化→ 紫外光(253.7nm)

—被螢光體(原始狀態)吸收→ 螢光體(激發狀態)

—放出可見光→ 螢光體(原始狀態)



Copy Rights Reserved © 2005

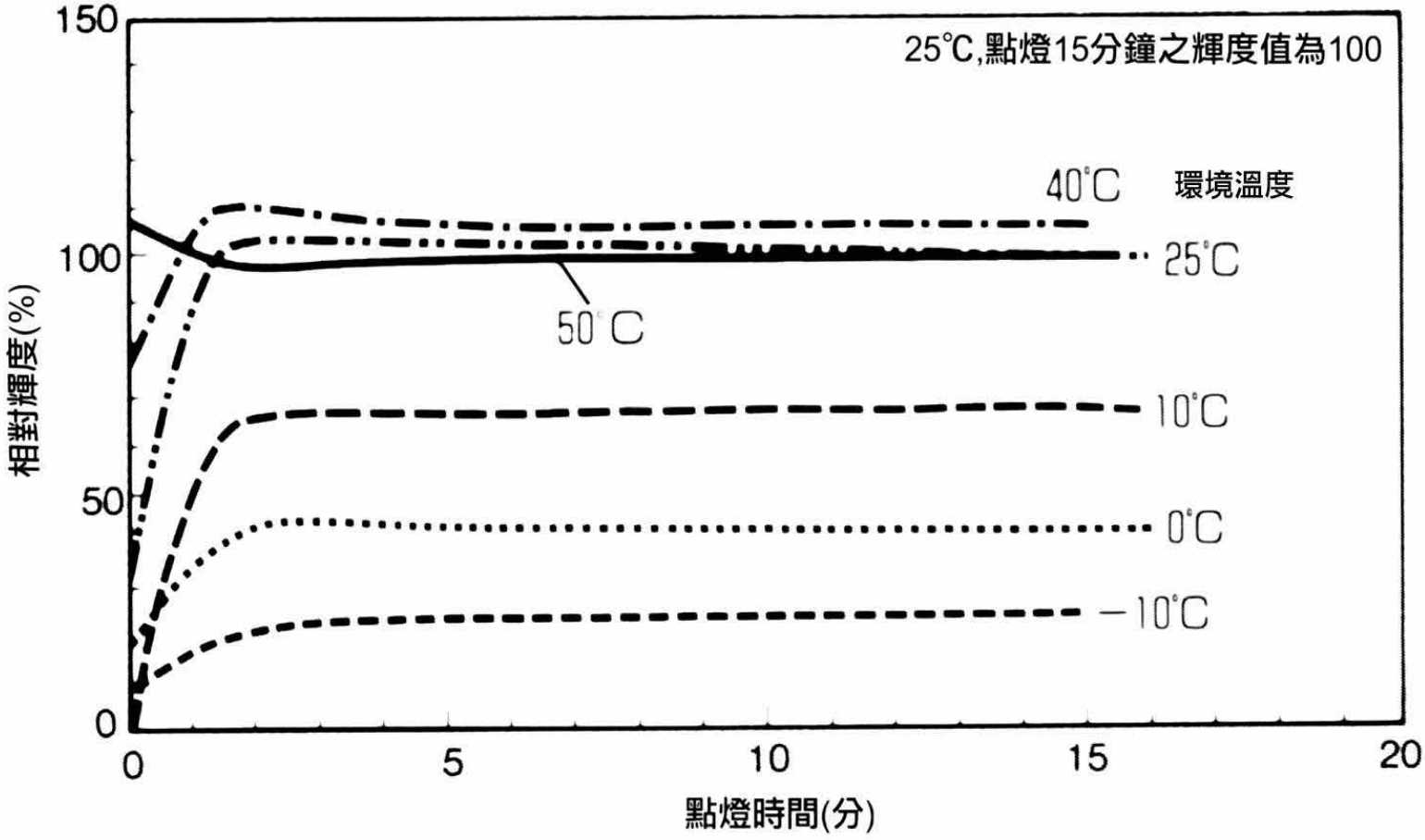
影響 CCFL 的因素

1. 玻璃管徑
2. 燈管長度
3. 燈管形狀（直管、L管、冂管、U管、W管…）
4. 電極形狀及種類（片狀、杯狀，鎢合金、鉬合金…）
5. 水銀量（水銀蒸氣壓＝$6X10^{-3}$ tor 時 253.7 nm 輻射效率最大）
6. 惰性氣體混和比例 (Ne + Ar)
7. 惰性氣體充填壓力
8. 周圍環境溫度（影響管壁及電極溫度）
9. 色度 (y 值 – 螢光劑配方)
10. 螢光劑塗佈 （厚薄、均齊度…）
11. 驅動電壓、電流 及 整流波形

Copy Rights Reserved © 2005

CCFL的輝度

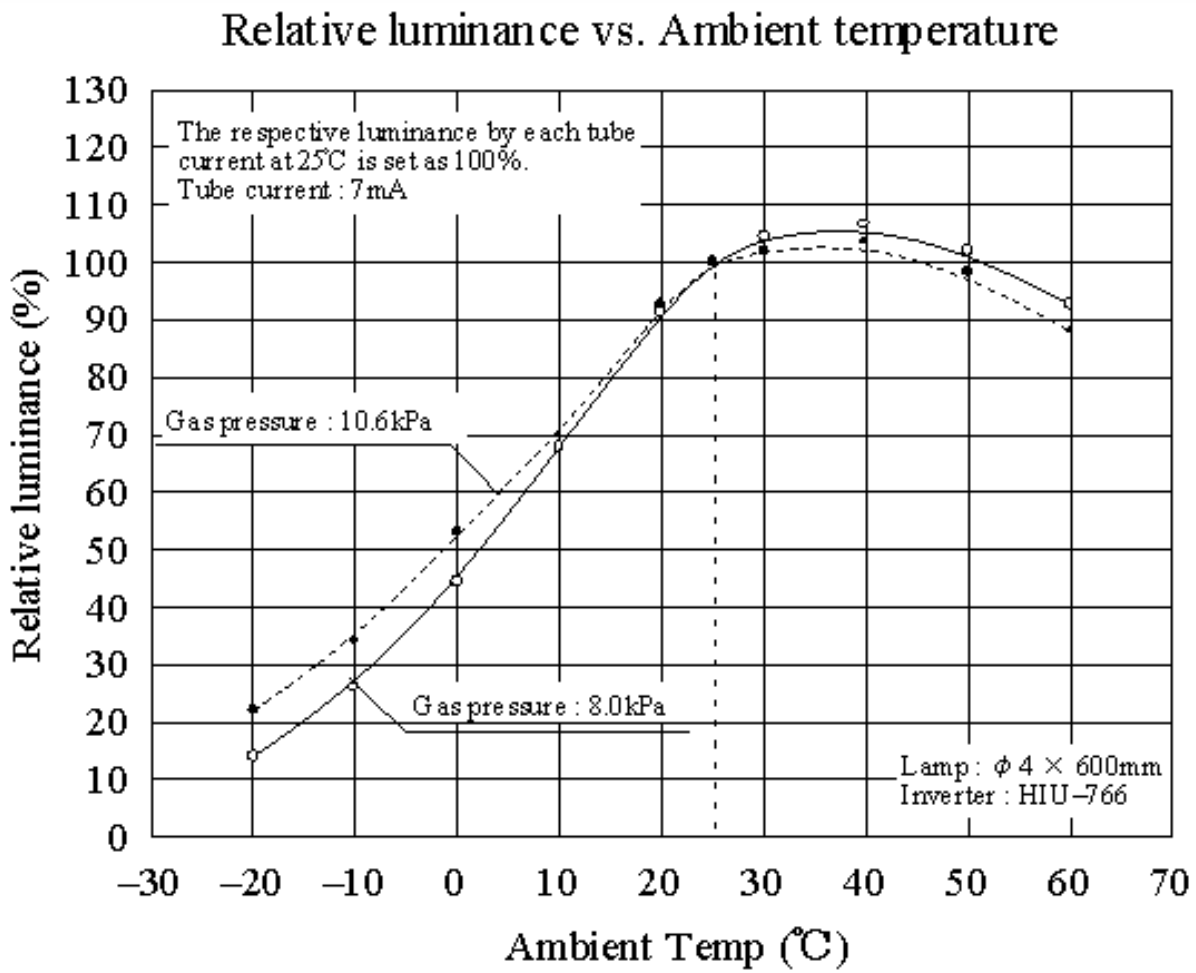
– 暖機時間與環境溫度的影響 --



Copy Rights Reserved © 2005

CCFL的輝度

– 環境溫度與氣體填充壓力的影響 –

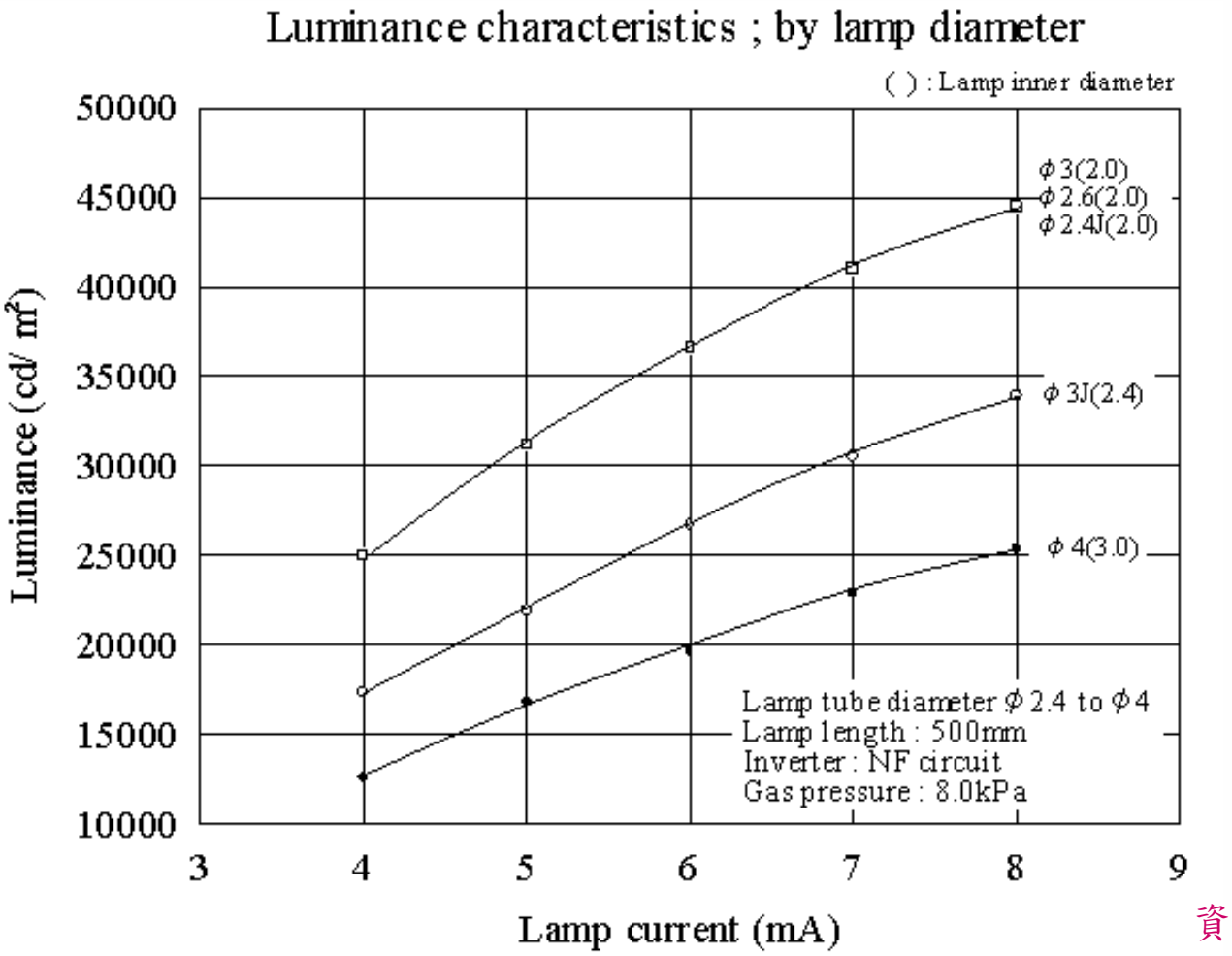


資料來源：

Copy Rights Reserved © 2005

CCFL的輝度

–燈管直徑與點燈電流的影響 --

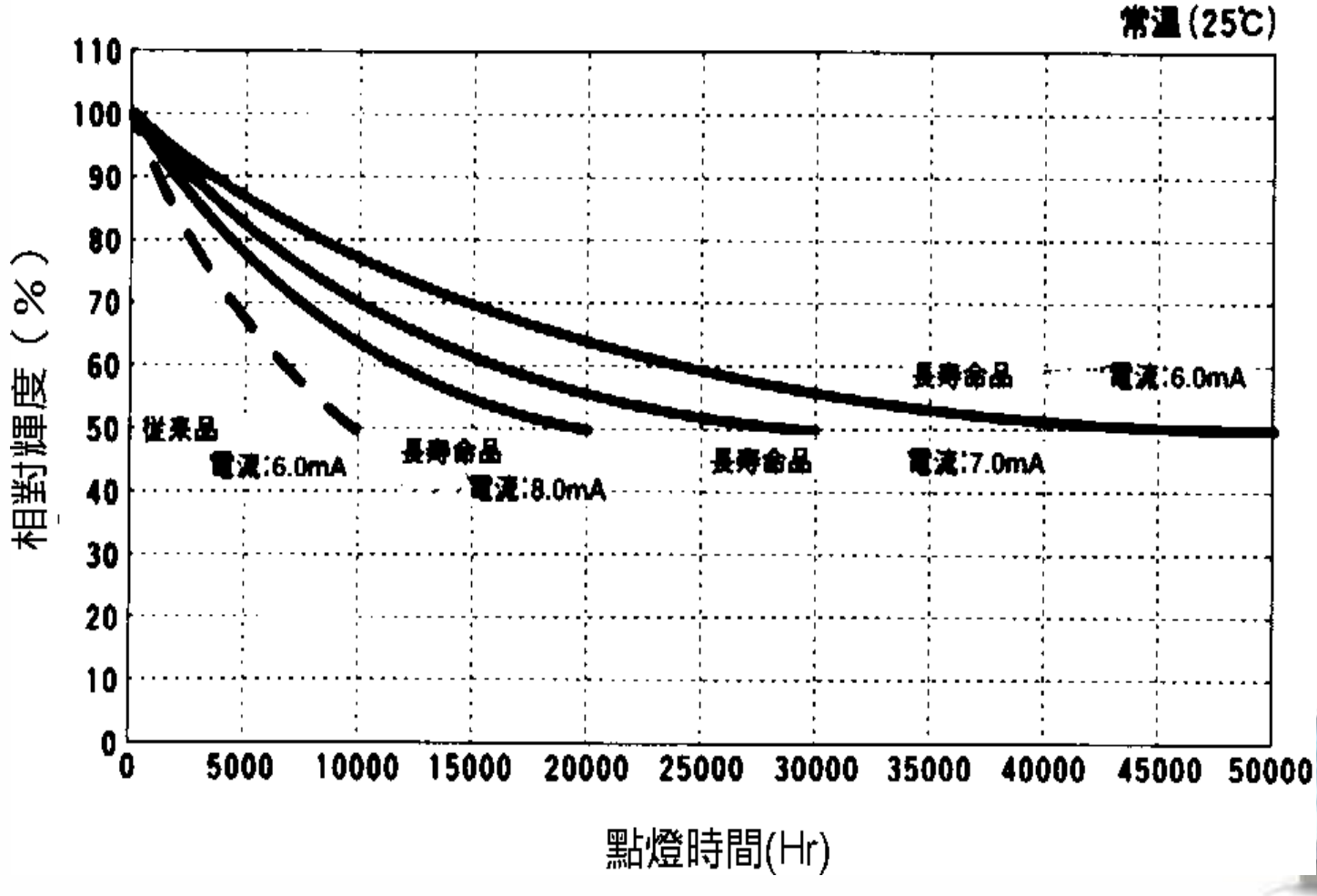


資料來源：

Copy Rights Reserved © 2005

CCFL的壽命

– 燈管點燈電流的影響 --



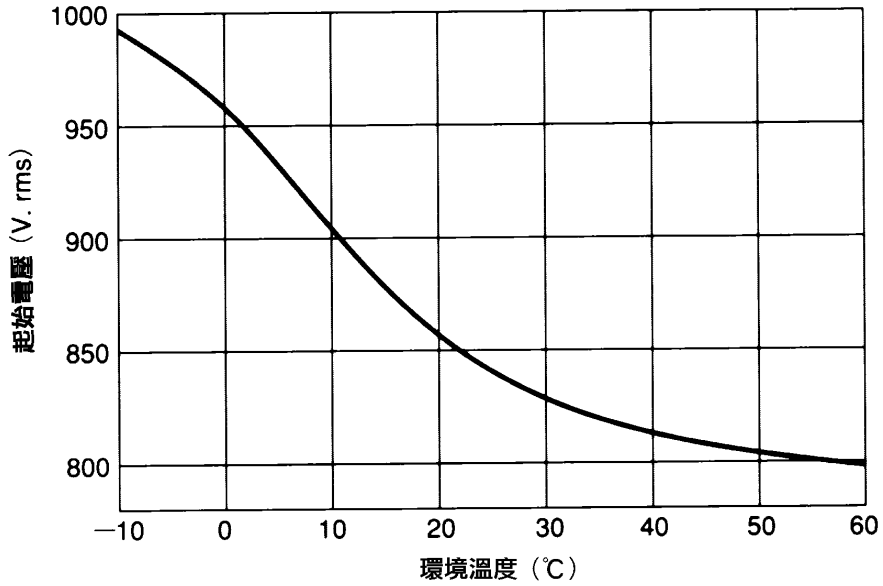
Copy Rights Reserved © 2005

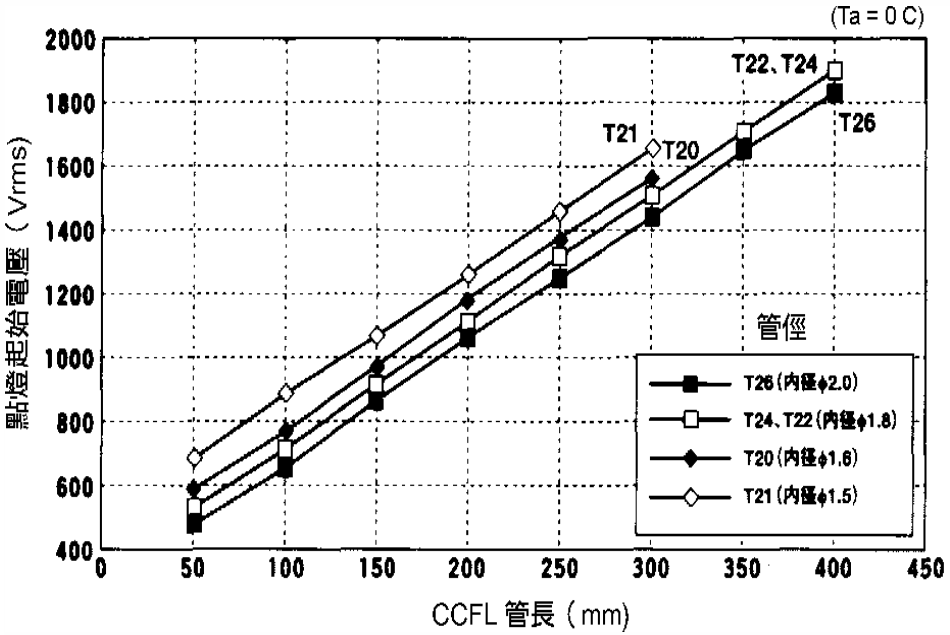
CCFL的驅動

– 管徑、管長與環境溫度的影響 --

Inverter: 直流電轉高壓、高頻交流電驅動。

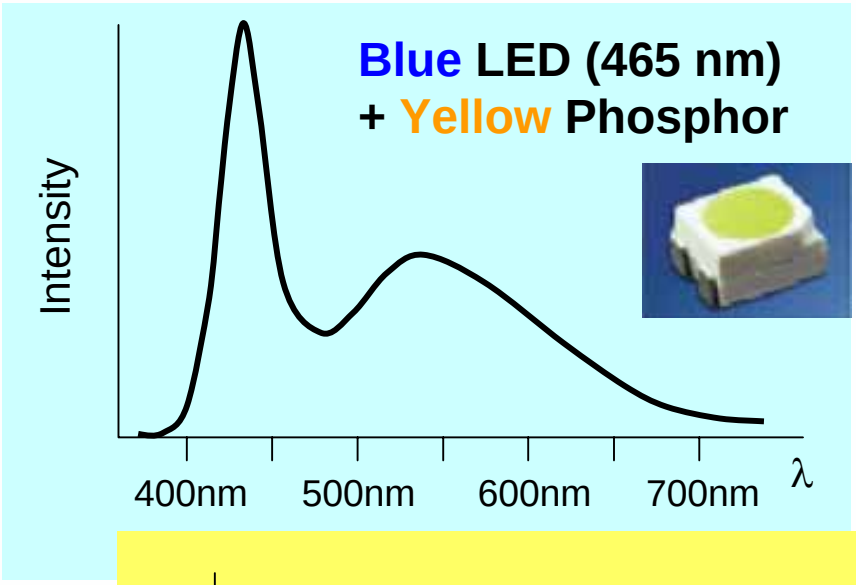
- 啓動電壓
- 振盪頻率
- 變壓整流波形
- 管電流平衡（多燈管驅動）

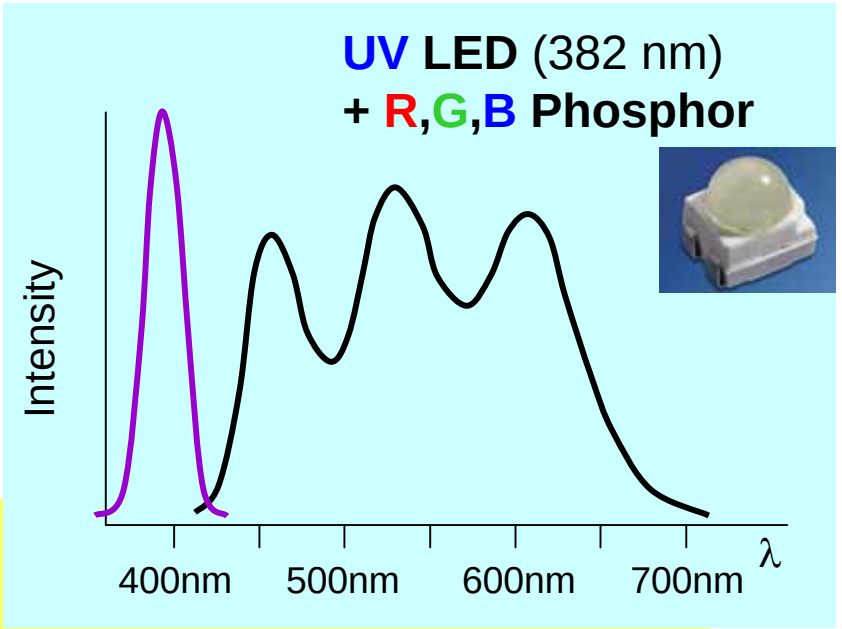


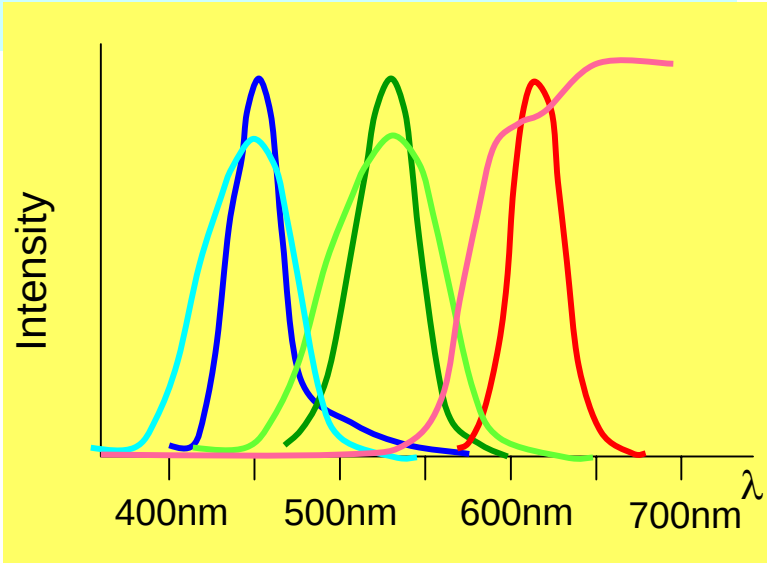


Copy Rights Reserved © 2005

Lighting and Spectrum -- LEDs





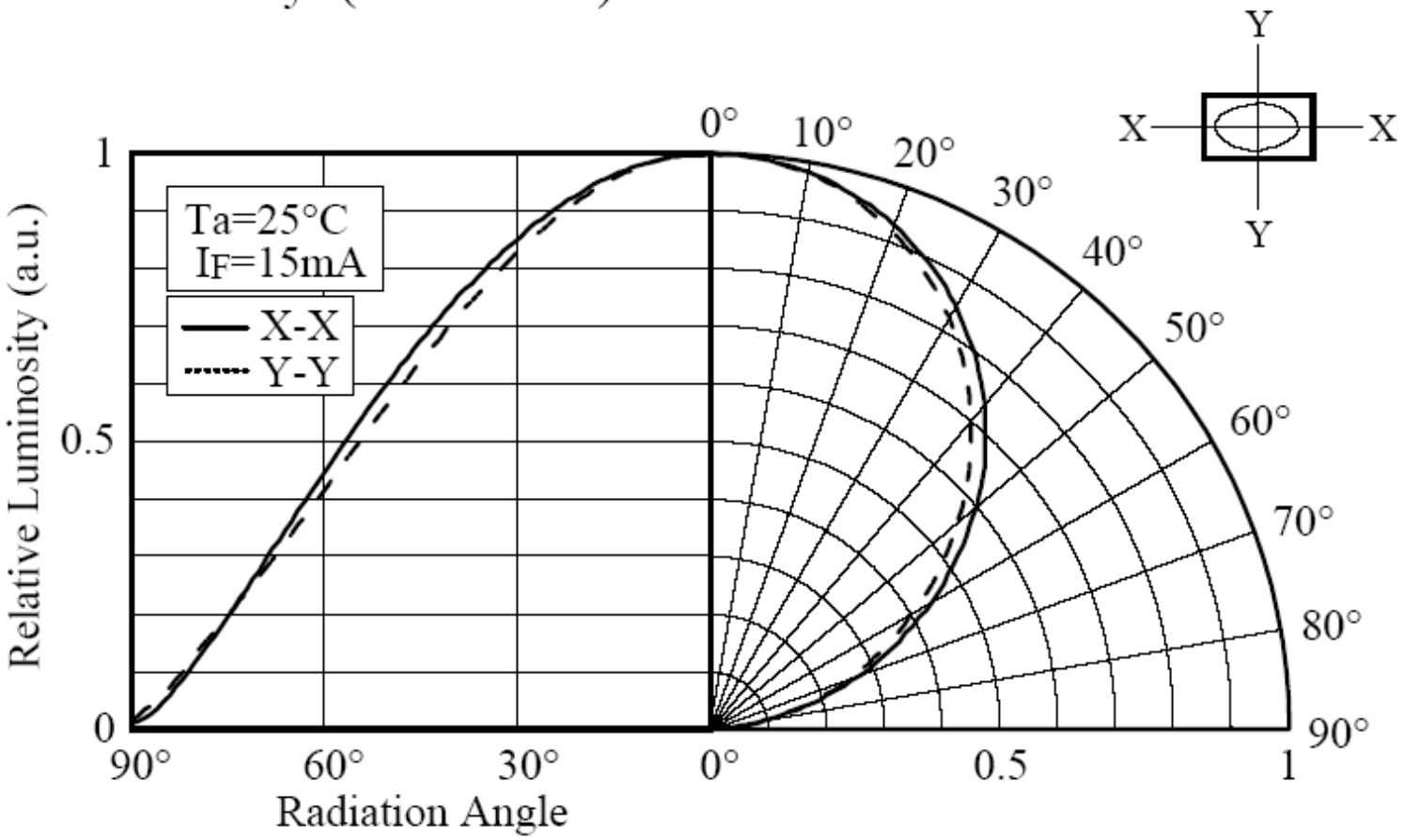


- **R,G,B Multi-chip single package**
- **R,G,B Individual package (external light mixing)**

Copy Rights Reserved © 2005

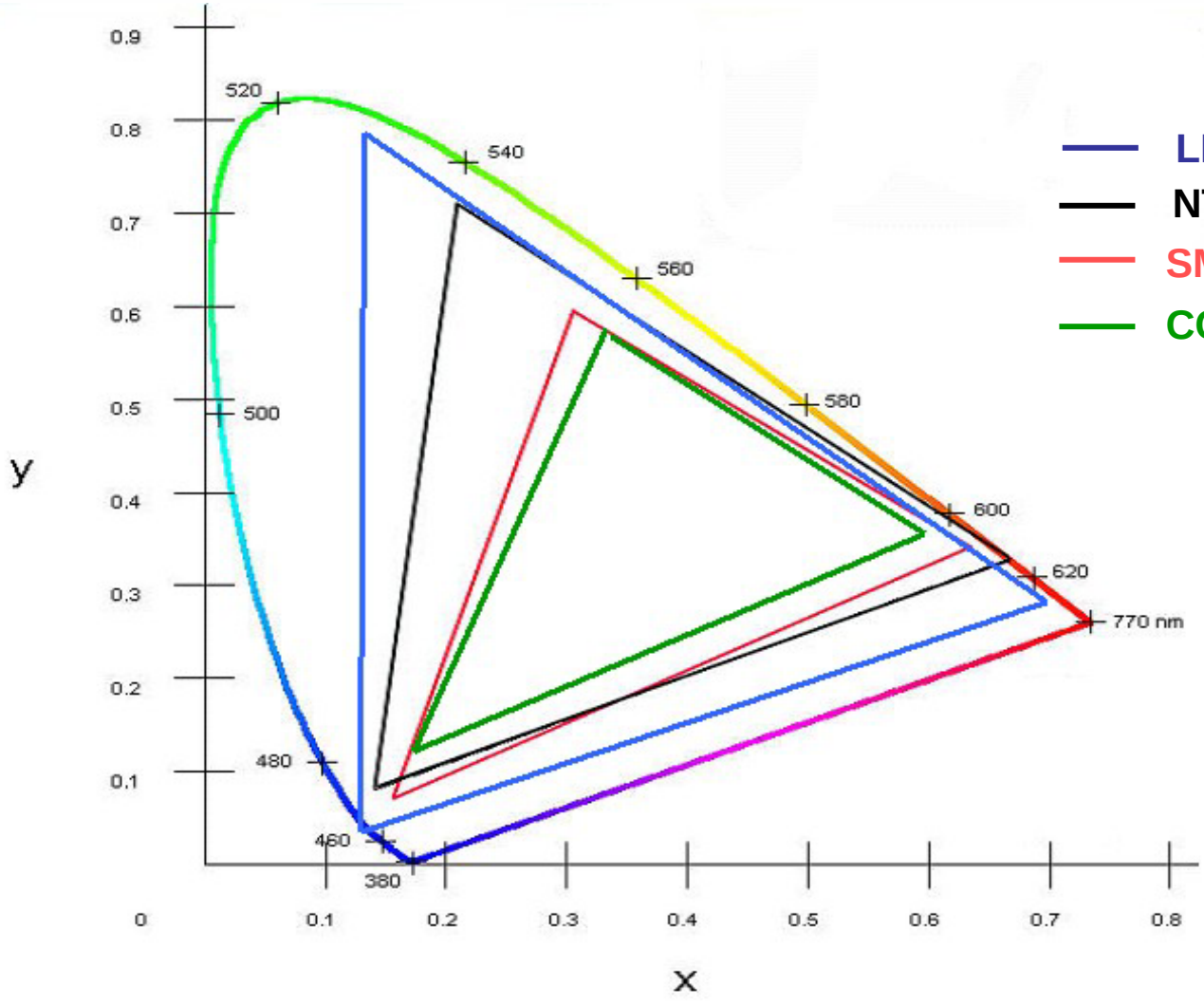
LED – Luminosity and Radiation Angle

■ Directivity (NECW215)



Copy Rights Reserved © 2005

Color Gamut on CIE Diagram

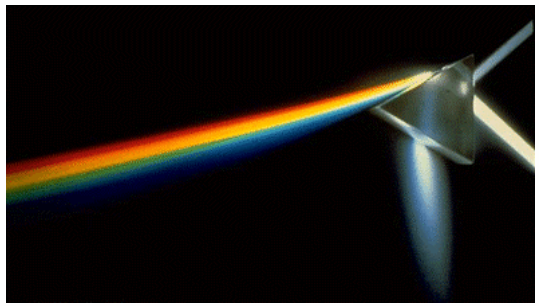


LED
NTSC
SMPTE-C
CCFL

Copy Rights Reserved © 2005

課 程 大 綱

- 背光模組的角色及功能
- 光源與色彩
- 背光模組的組成與光學
- 背光模組的規格與量測
- 背光模組的發展及挑戰
- Q & A

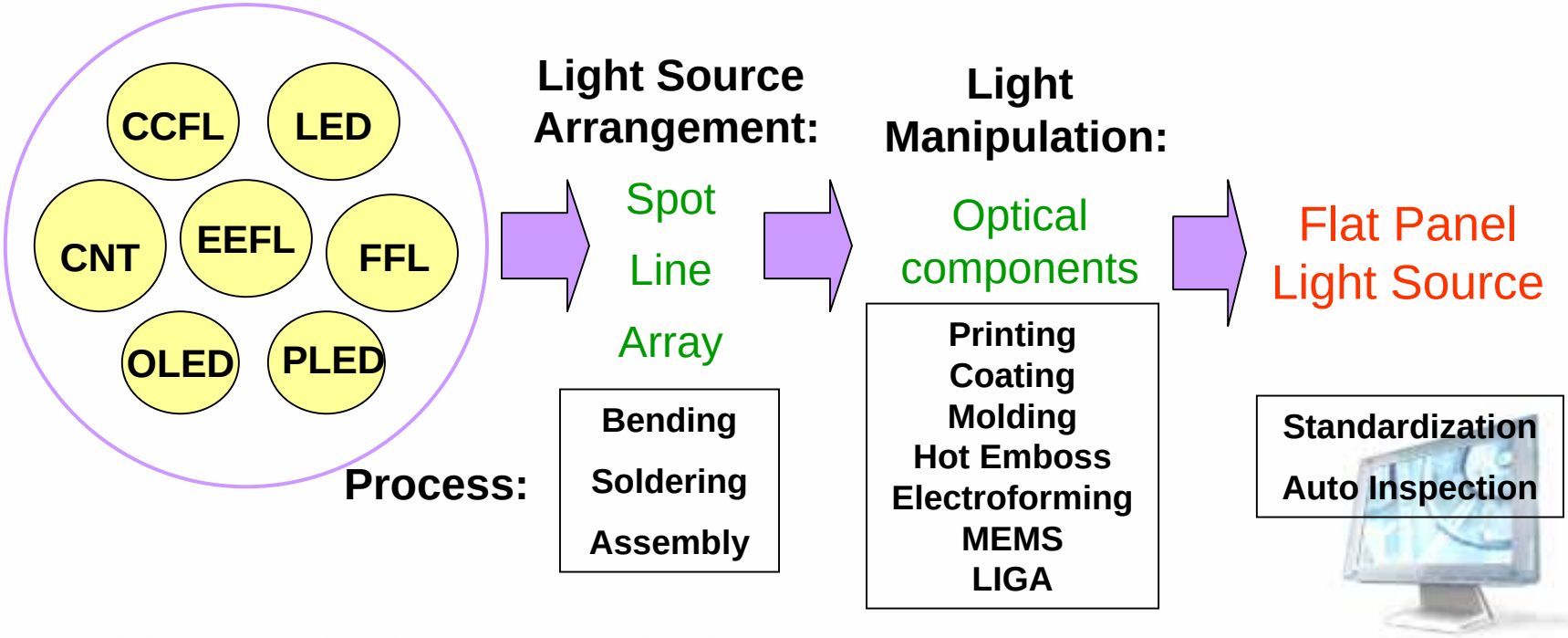


Copy Rights Reserved © 2005

A Play of Lights…

Optical concepts:

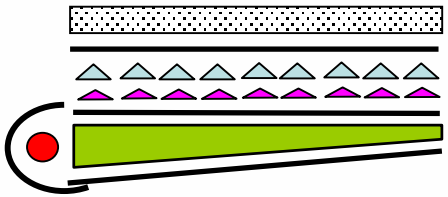
1. **Linear: Making the most efficient use of light and guiding each ray of light to the most proper position.**
2. **Nonlinear: Applying sub-micron scale pattern (under 1 μm) to recycle light with phase differentiation.**



Copy Rights Reserved © 2005

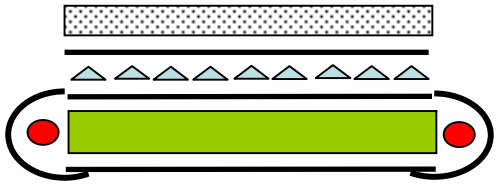
Backlight Configurations & Applications

Notebook

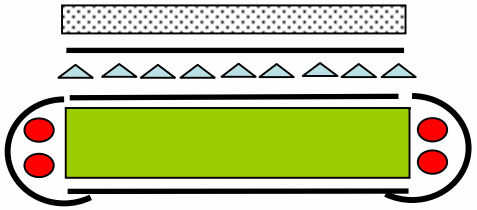


1-Lamp Edge-light
Notebook 14"/15"
150~200 cd/m^2
4.8 mm / 380g
30,000 Hrs

Desktop Monitor

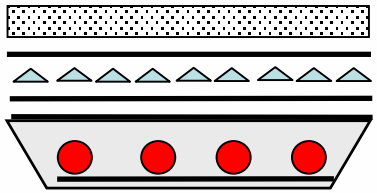


2 -Lamps Edge-light
Monitor 15"
200~250 cd/m^2
View Angle > 160°
50,000 Hrs.



4 -Lamps Side-light
Monitor 17"/19"
280~350 cd/m^2
View Angle > 160°
50,000 Hrs

TV



Direct-light
TV 20"+
450~600 cd/m^2
View Angle > 160°
72% NTSC
50,000 Hrs

200~250 cd/m^2
2.2 mm / 230g
50,000 Hrs
Energy Efficient
Green Design

350~450 cd/m^2
> 72% NTSC
70,000 Hrs
Cost Down
Green Design

500~800 cd/m^2
100% NTSC
100,000 Hrs
Energy Saving
Green Design

Copy Rights Reserved © 2005

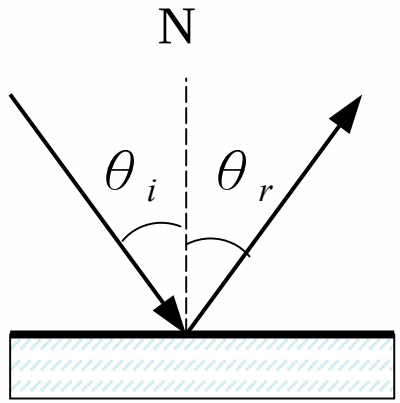
幾何光學 與 反射定律

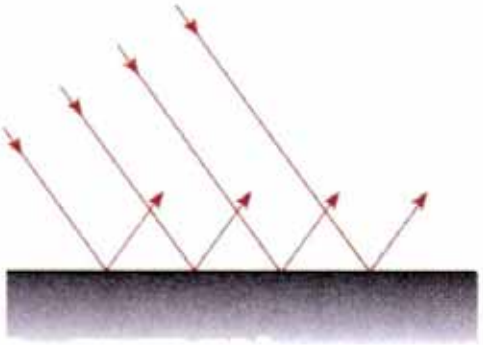
- **Ray Approximation:** 假設光波依一直線方向前進。

$$(\lambda << d)$$

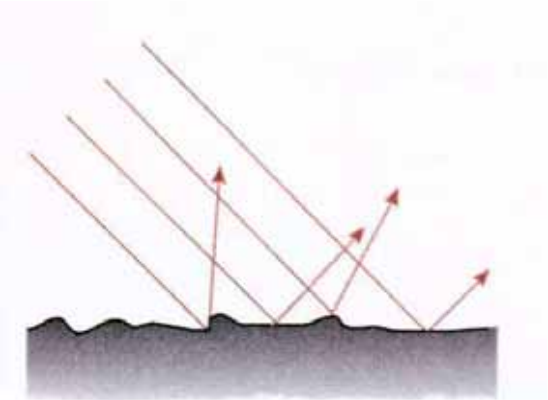
- 反射定律： $\theta_i = \theta_r$

入射線、出射線 及 反射面之垂直法線皆在同一平面。





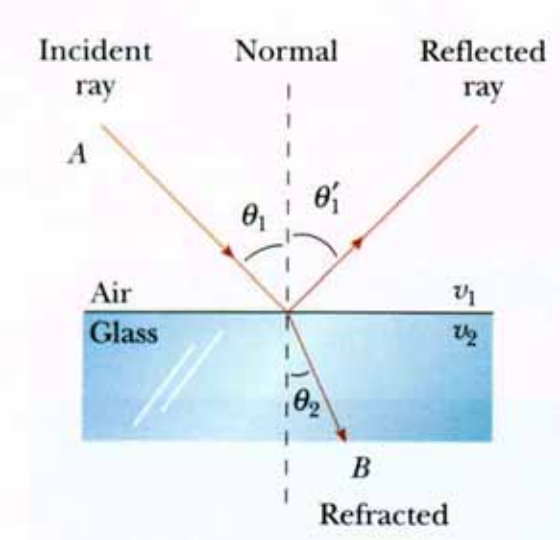
鏡面反射
(λ > 表面粗度)

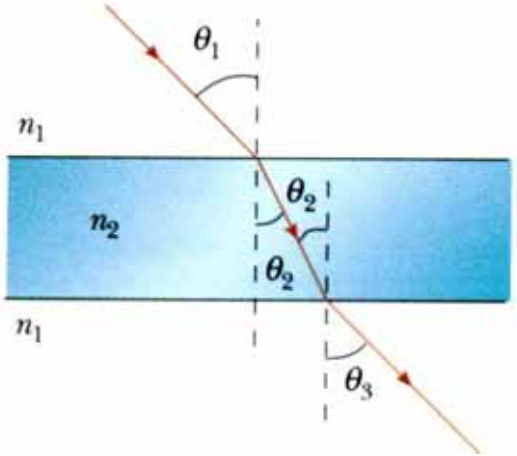


粗糙表面造成「漫射」
(Diffusion)

Copy Rights Reserved © 2005

折射定律





- 光在不同介質中的速度不同。
- 光在真空中的速度最大。

- **折射率 (Index of Refraction) :**

$$n = \frac{\text{真空中光速}}{\text{介質中光速}} = \frac{c}{v}$$

- **Snell's Law:**

$$n_1 \sin\theta_1 = n_2 \sin\theta_2$$

Copy Rights Reserved © 2005

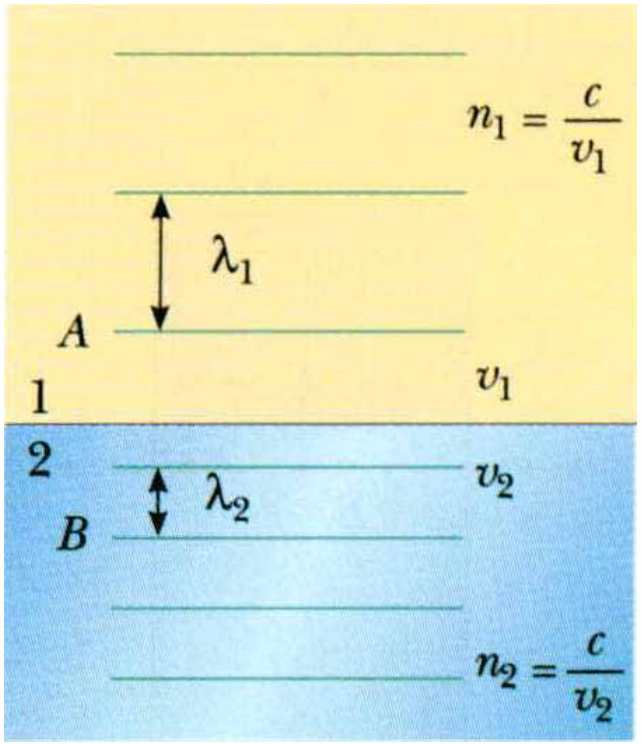
光的傳遞 -- 波動理論

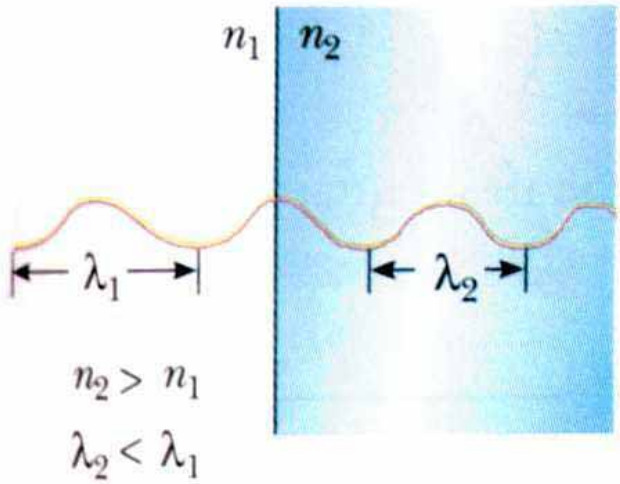
- 光在不同介質中的頻率不變。

$$v = f\lambda$$

$$f_1 = f_2 = f$$

$$\frac{\lambda_1}{\lambda_2} = \frac{v_1}{v_2} = \frac{n_2}{n_1}$$

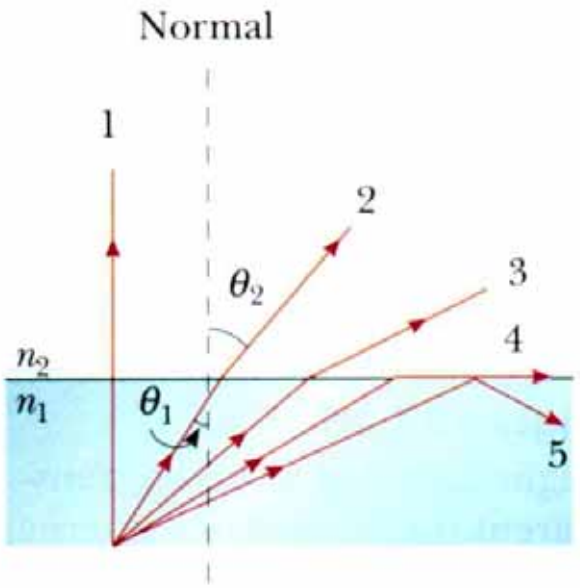


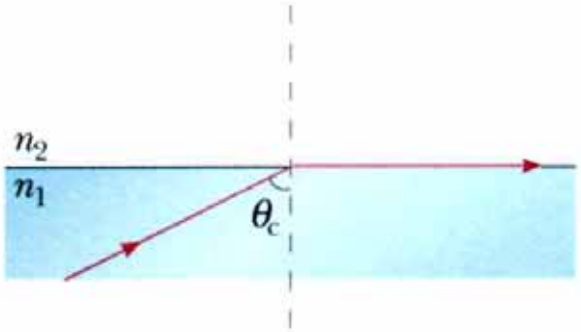


v = speed
λ = wave length
f = frequency

Copy Rights Reserved © 2005

介質導光的原理



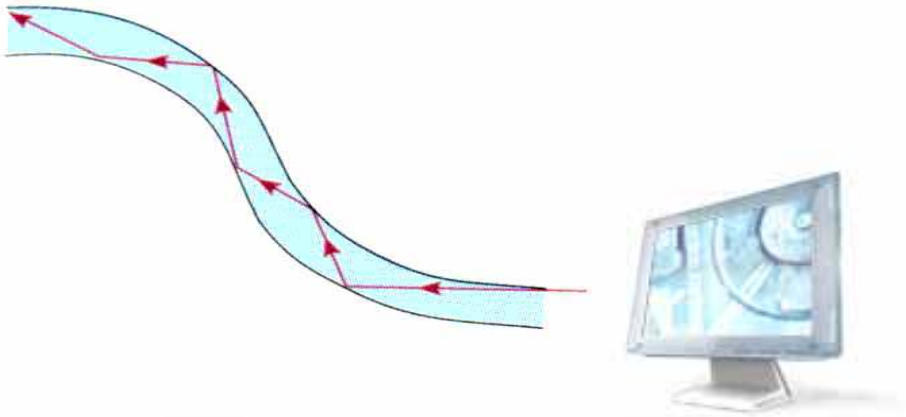


- 全反射 與 臨界角：

$$\sin\theta_c = \frac{n_2}{n_1} \qquad (\text{where } n_1 > n_2)$$

$\theta > \theta_c$：全反射(Total Reflection)

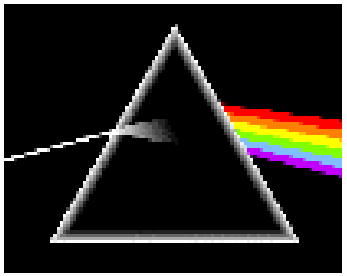
$\theta < \theta_c$：折射(Refraction)

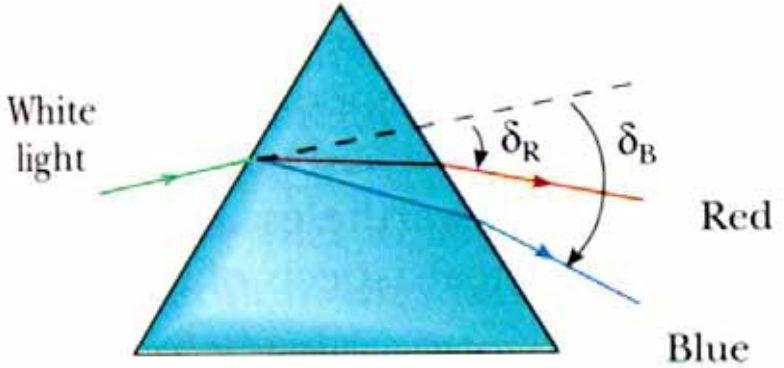


Copy Rights Reserved © 2005

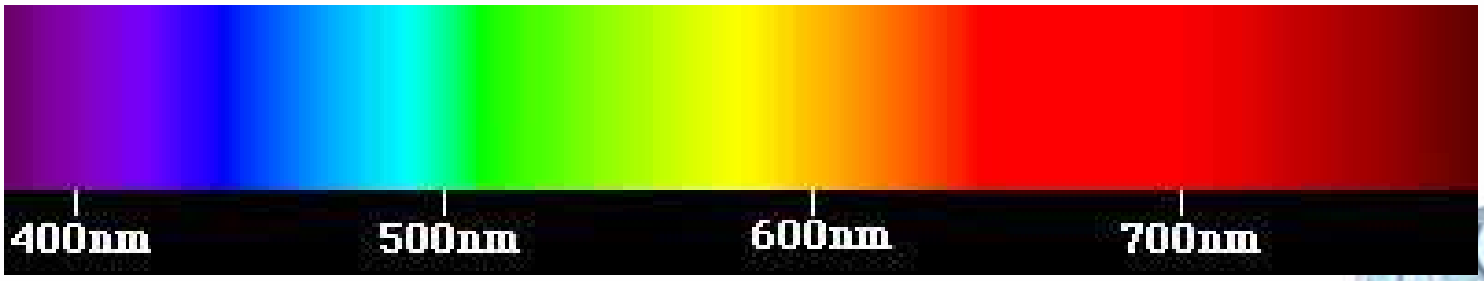
散射：菱鏡分光與可見光光譜

- 散射 (Dispersion)：λ越短 → *n* 越小 → 折射角 δ越大。



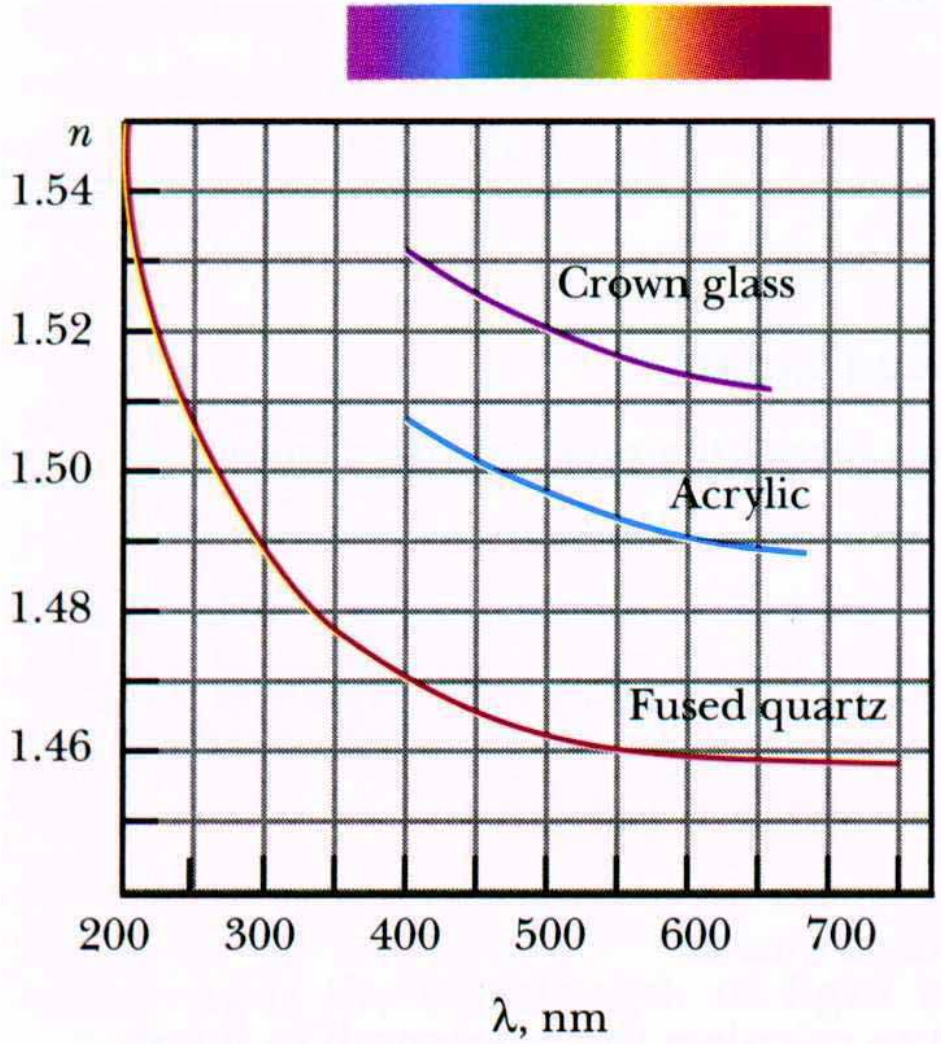


- 可見光的光譜：



Copy Rights Reserved © 2005

折射率 與 光波長 的關係



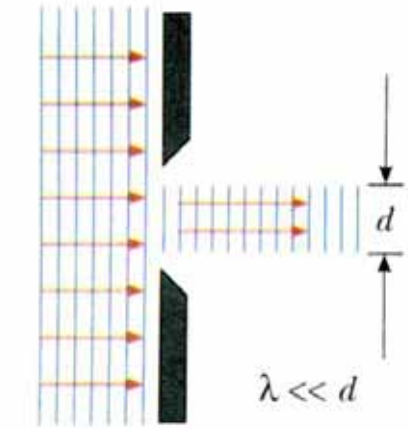
幾何光學

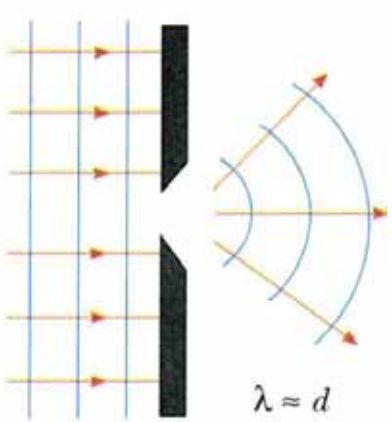
繞射光學

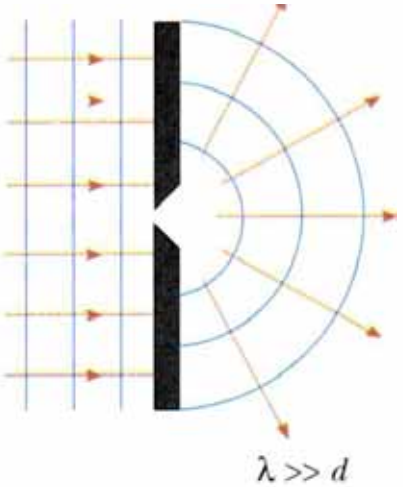
Copy Rights Reserved © 2005

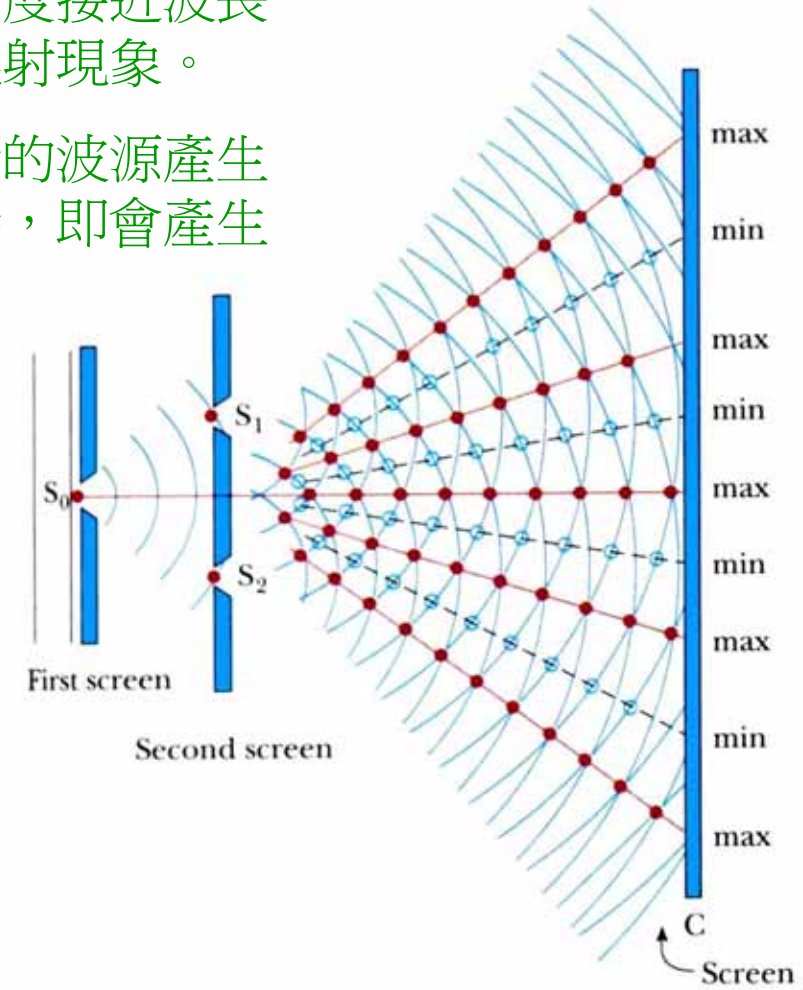
光的繞射與干涉現象

- 當物件特性長度接近波長時，即會產繞射現象。
- 兩個相位同步的波源產生的波傳重疊時，即會產生干涉現象。





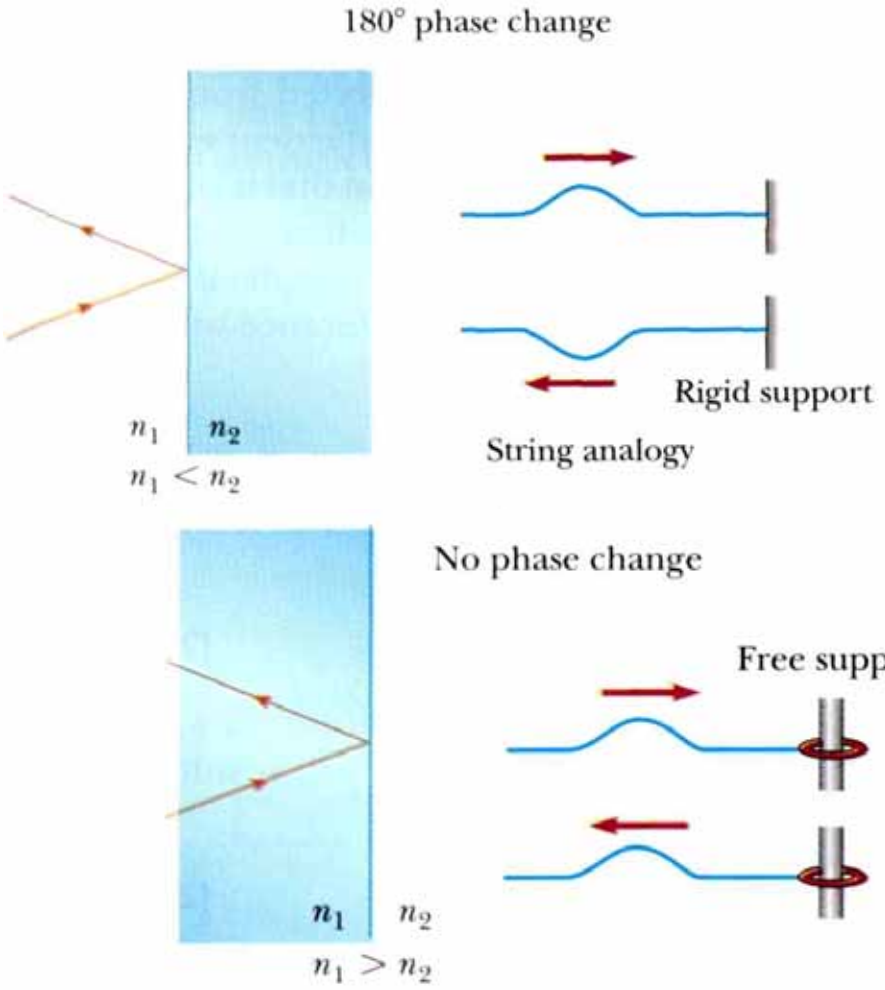


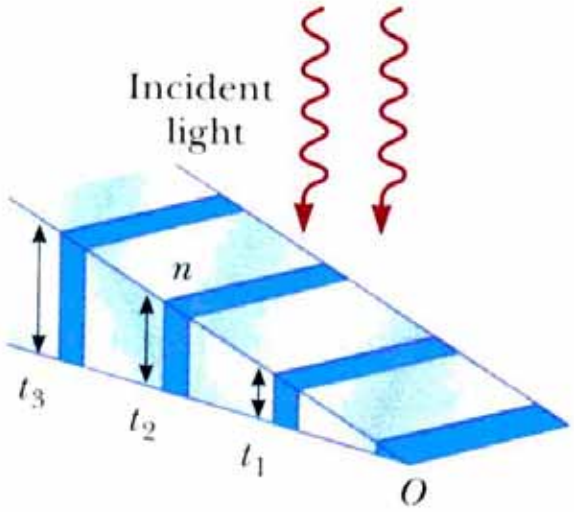


Copy Rights Reserved © 2005

光的相位變化

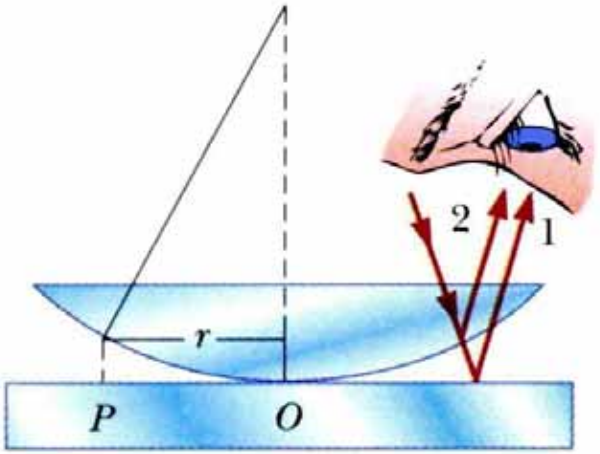
– 因介面折射率差異而造成的干涉現象 –

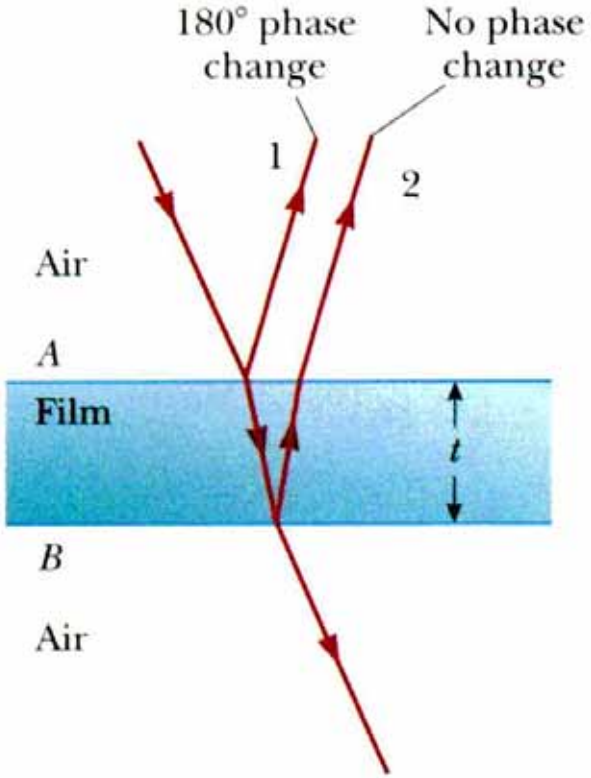


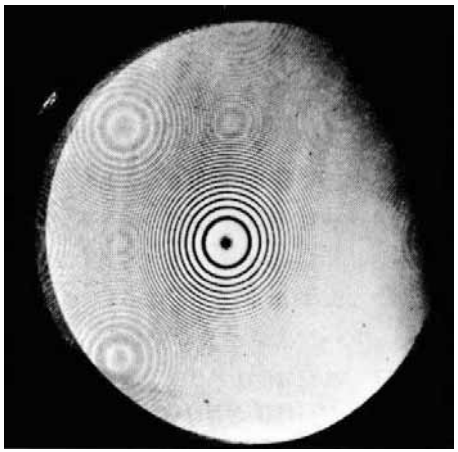


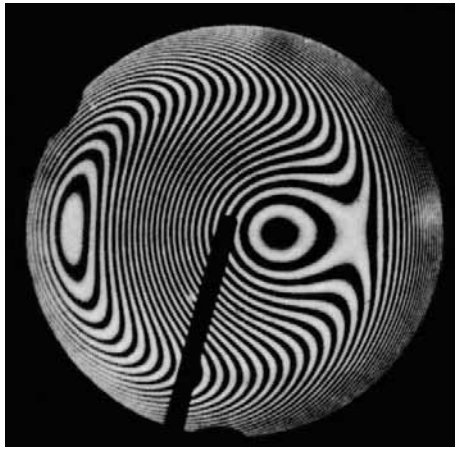
Copy Rights Reserved © 2005

牛頓環－光的干涉現象









Copy Rights Reserved © 2005

凹面鏡的聚焦與反射

- 焦距： $f = \frac{R}{2}$

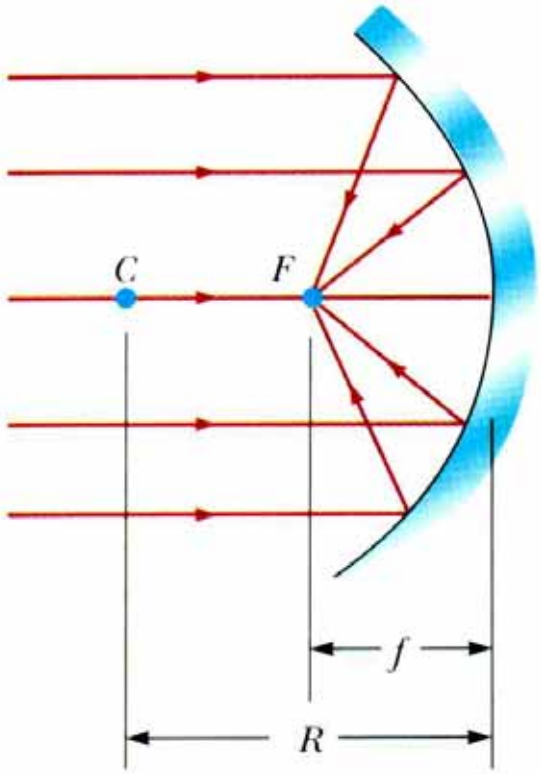
  R 爲鏡面曲率半徑。

- **Mirror Equation:**

$$\frac{1}{p} = \frac{1}{q} = \frac{1}{f}$$

p – 鏡子頂點至物體距離。

q – 鏡子頂點至影像距離。

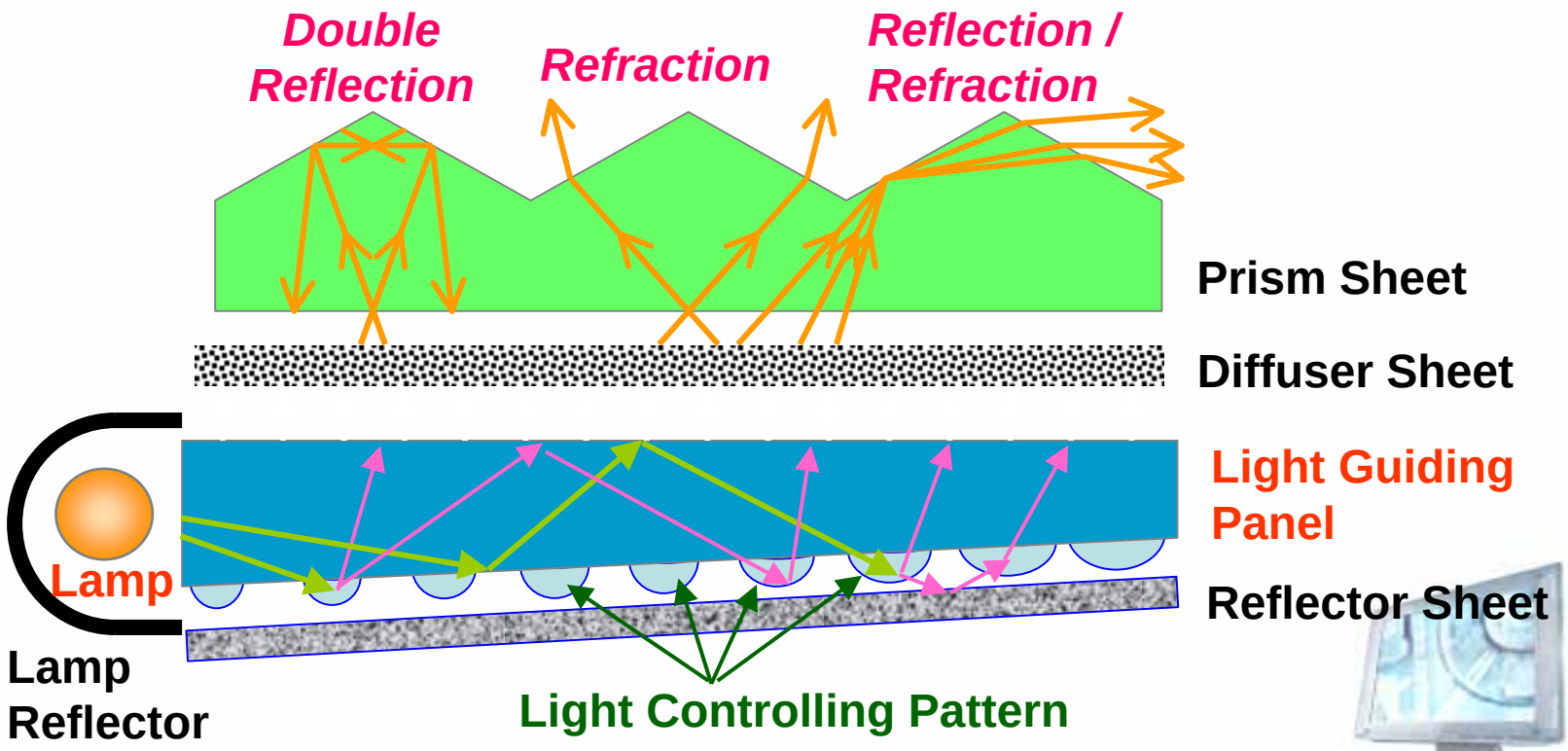


- 平行入射光會被聚焦在焦點。
- 位於焦點之光源的輻射光會被平行反射出去。

Copy Rights Reserved © 2005

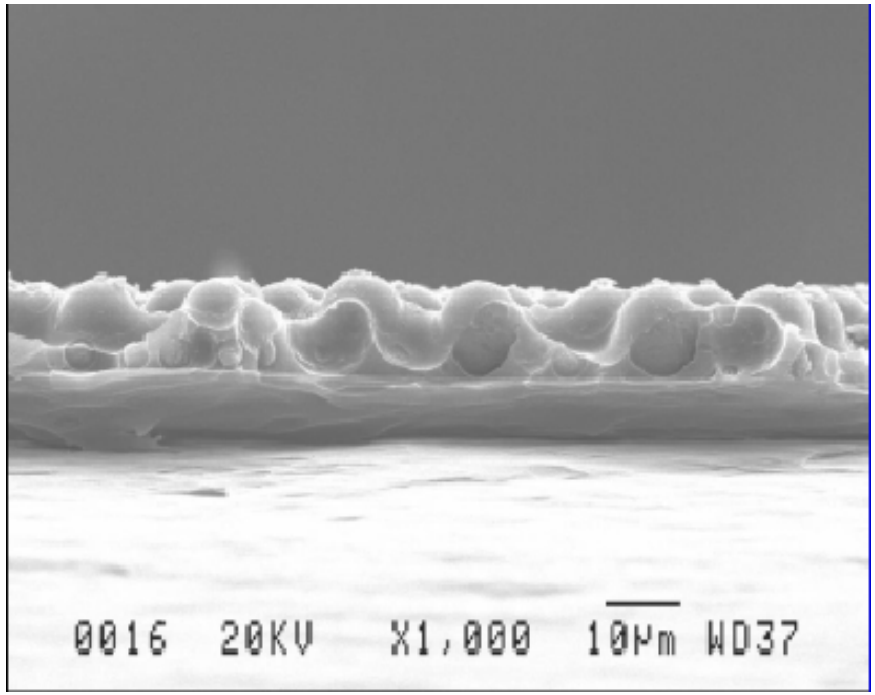
Backlight Optics

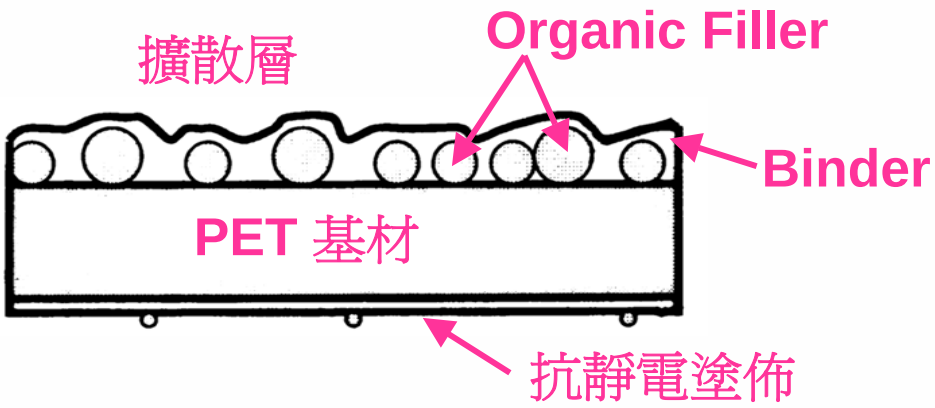
- Applying the principles of reflection, refraction and total internal reflection to achieve homogenous lighting effects.



Copy Rights Reserved © 2005

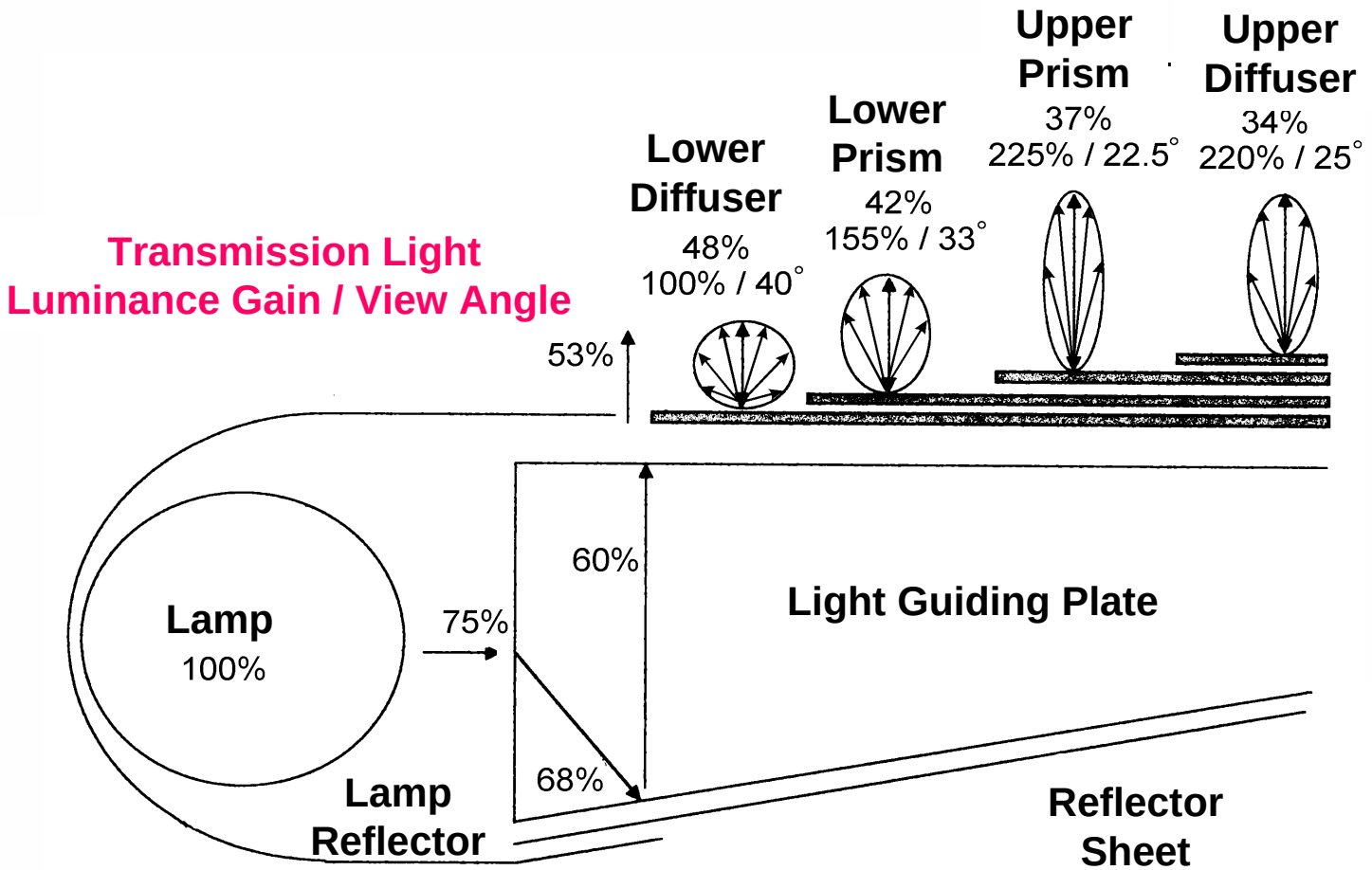
擴 散 片 (Diffuser Sheet)





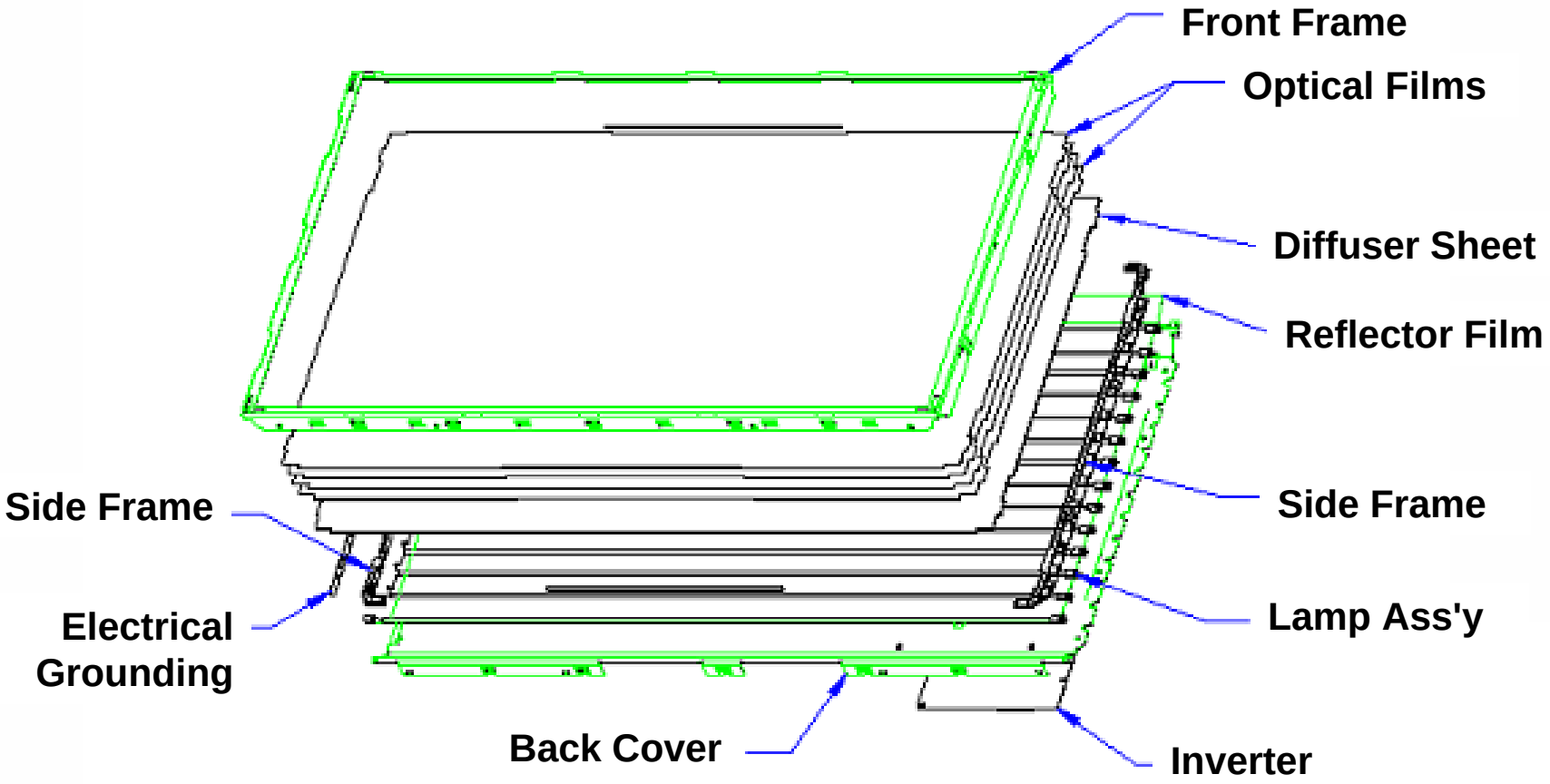
Copy Rights Reserved © 2005

Current Structure -- Efficiency Lost …



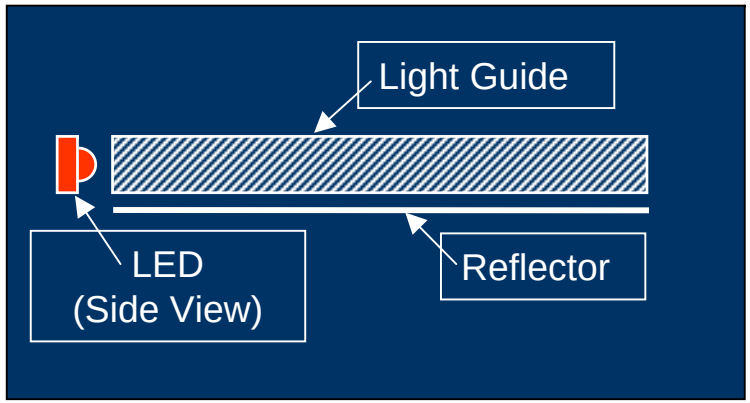
Copy Rights Reserved © 2005

Conventional Direct-Light BLU for TV

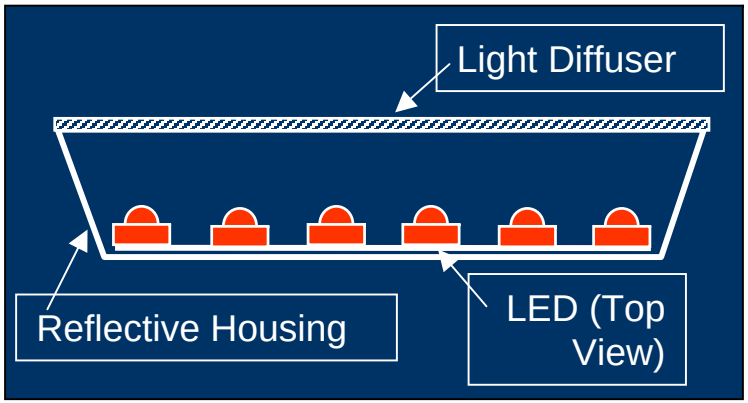


Copy Rights Reserved © 2005

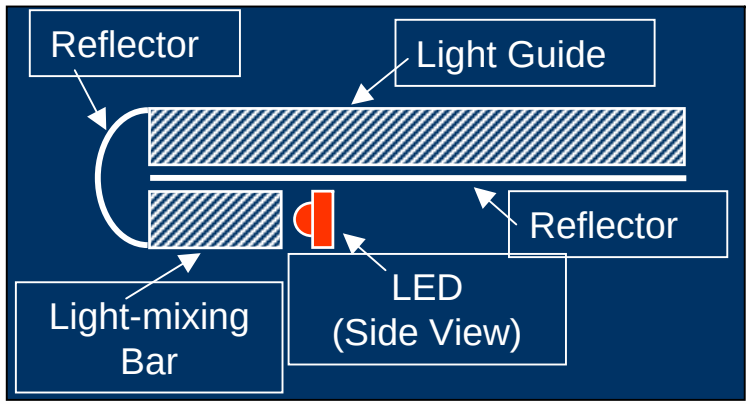
Arrangement of LEDs in Backlight



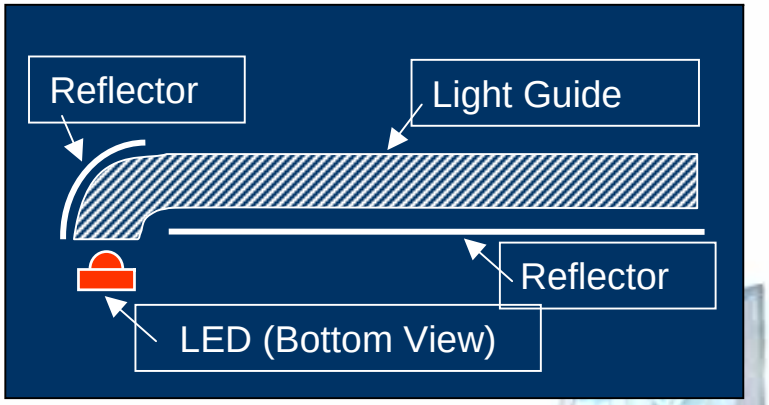
Edge-Lighting



Direct-Lighting



Folded-Back Edge-Lighting

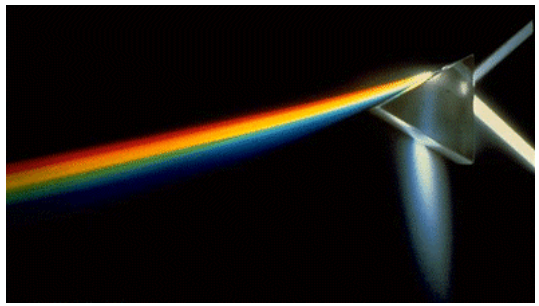


Angled Edge-Lighting

Copy Rights Reserved © 2005

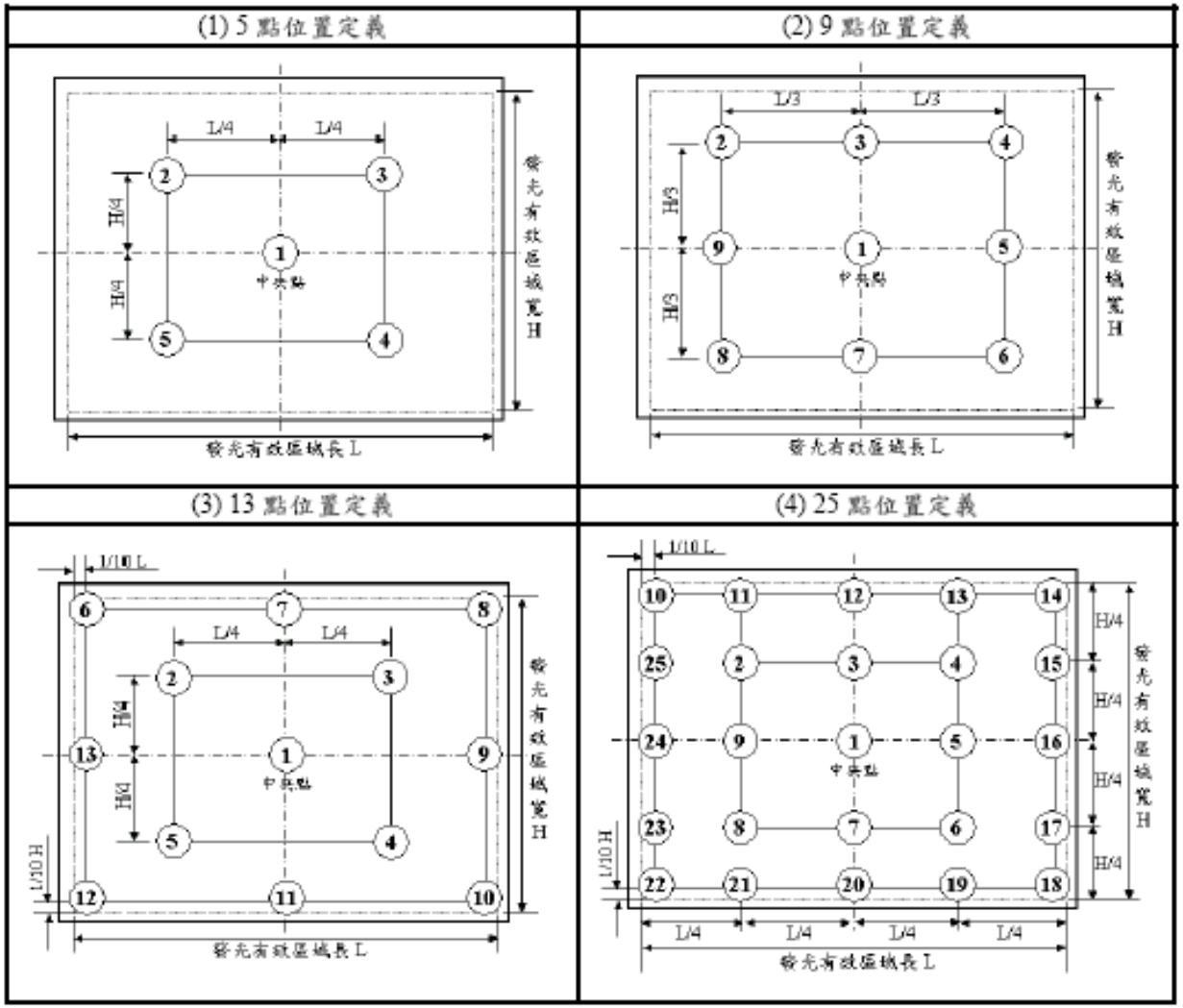
課 程 大 綱

- 背光模組的角色及功能
- 光源與色彩
- 背光模組的組成與光學
- 背光模組的規格與量測
- 背光模組的發展及挑戰
- Q & A



Copy Rights Reserved © 2005

背光模組的光學評量



- ✓ 中心輝度
- ✓ 中心色度
- ✓ 平均輝度
- ✓ 均齊度
- ✓ 品味

資料來源：

台灣平面顯示器材料與元件產業協會
Taiwan Flat Panel Display Materials and Devices Association
TDMDA

Copy Rights Reserved © 2005

光的度量名稱、定義 與 單位

度量名稱	符號	定義	單位
輻射能量 Radiation Energy	*Q*	光源輻射出之能量 (在光譜範圍內)。	1 卡 ＝ 4.18 *J* ＝ 10^7 erg
光通量 Luminous flux	ψ	光源在單位時間內所發的輻射能量： ψ ＝ *dQ*/*dt*	流明 (lm) 瓦特 (W=*J*/s)
光度 Luminous intensity	*I*	光源在某一方向之單位立體角(ω)內所發射之光通量： *I* ＝ *dψ*/*dω* (球面積＝4πr²)	燭光 (cd) ~~(1 cd = 4π lm)~~ (立體角4π)
輻射出度 Luminous exitance	*M*	*S* 面積光源之單位面積發射的光通量： *M* ＝ *dψ*/*dS*	W/m² Lux = lm/m² 1 米燭光 = 1 lux
照度 Illumination	*E*	*S* 面積被照體之單位面積上所受的光通量： *E* ＝ *dψ*/*dS* (照度與光源距離之平方成反比)	
輝度 Luminance	*L*	光源在某一方向之單位面積 (*S*) 所發出的光度 (*I*)： *L* ＝ $d^2ψ/dω(dS\cos θ)$ ＝ *dI*/(*dS* cos θ) (θ 為視線與平面法線之夾角)	nit (cd/m²) ~~(1 lux = π nit)~~ (球體投影面積為 πr²)

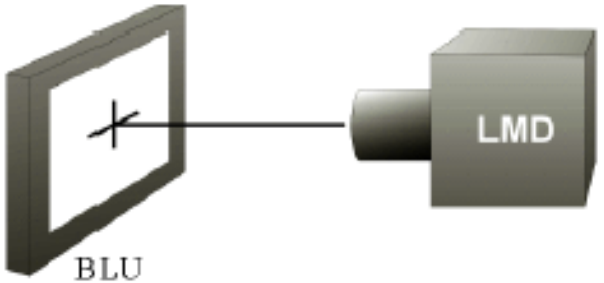
Copy Rights Reserved © 2005

背光模組的光學量測

3.2.1 中央輝度 (Central Luminance)

說明：量測螢幕中央點的輝度。單位：cd/m^2。符號：L

設定：量測位置定義圖中標記為 1 的中央點輝度。定位的不確定度必須小於螢幕對角線長度的±3%。



程序：在規定的操作條件下，量測螢幕中央點的輝度。

分析：無。若對中央點量測數次，可計算其輝度平均值。

報告：報告中央輝度值，但有效數字不超過三位數。若對中央點量測數次，可報告平均值。

評論：請注意，此量測項目易受光量測儀器鏡頭耀光(lens flare)或炫光(veiling glare)的影響，因此量測時應避免上述現象以防誤差。

分析與報告－樣本數據		
輝度	中央	**43.9**
	平均	43.7
色度	中央	(0.277,0.285)
	平均	(0.279,0.284)

資料來源：

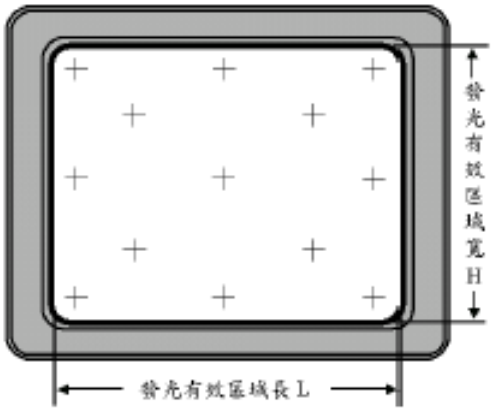
台灣平面顯示器材料與元件產業協會 Taiwan Flat Panel Display Materials and Devices Association TDMDA

Copy Rights Reserved © 2005

背光模組的輝度與均齊度

3.2.5 取樣均齊度 (Sampled Uniformity)

說明：量測螢幕上 5 點、9 點、13 點或 25 點量測點的輝度與色度座標(色度為選測項目)，並以百分比報告與輝度最大值相差最多的非均齊度，以及最大色差 $\Delta u'v'$ (選測項目)。也可以自由選擇是否量測相關色溫(correlated color temperature，CCT)的均勻度。**單位**：輝度的均齊度為百分比；色差無單位。符號：無。



設定：佈置光量測儀器量測螢幕 5 點、9 點、13 點或 25 點的輝度及色度—參閱圖 2、圖 3、圖 4 或圖 5。定位的不準確度需小於螢幕對角線長的 ±3%。

程序：在規定的操作條件下，量測 5 點(或 9 點、13 點、25 點)的輝度 L_i ($i = 5、9、13$ 或 25)，色度座標 (x, y) 或 (u', v')。

分析：從所量測到的輝度值 L_i 中 ($i = 5、9$ 或 13)決定輝度最小值 L_{min} 和輝度最大值 L_{max}，並計算平均值 L_{ave}，並根據下列公式計算非均齊度

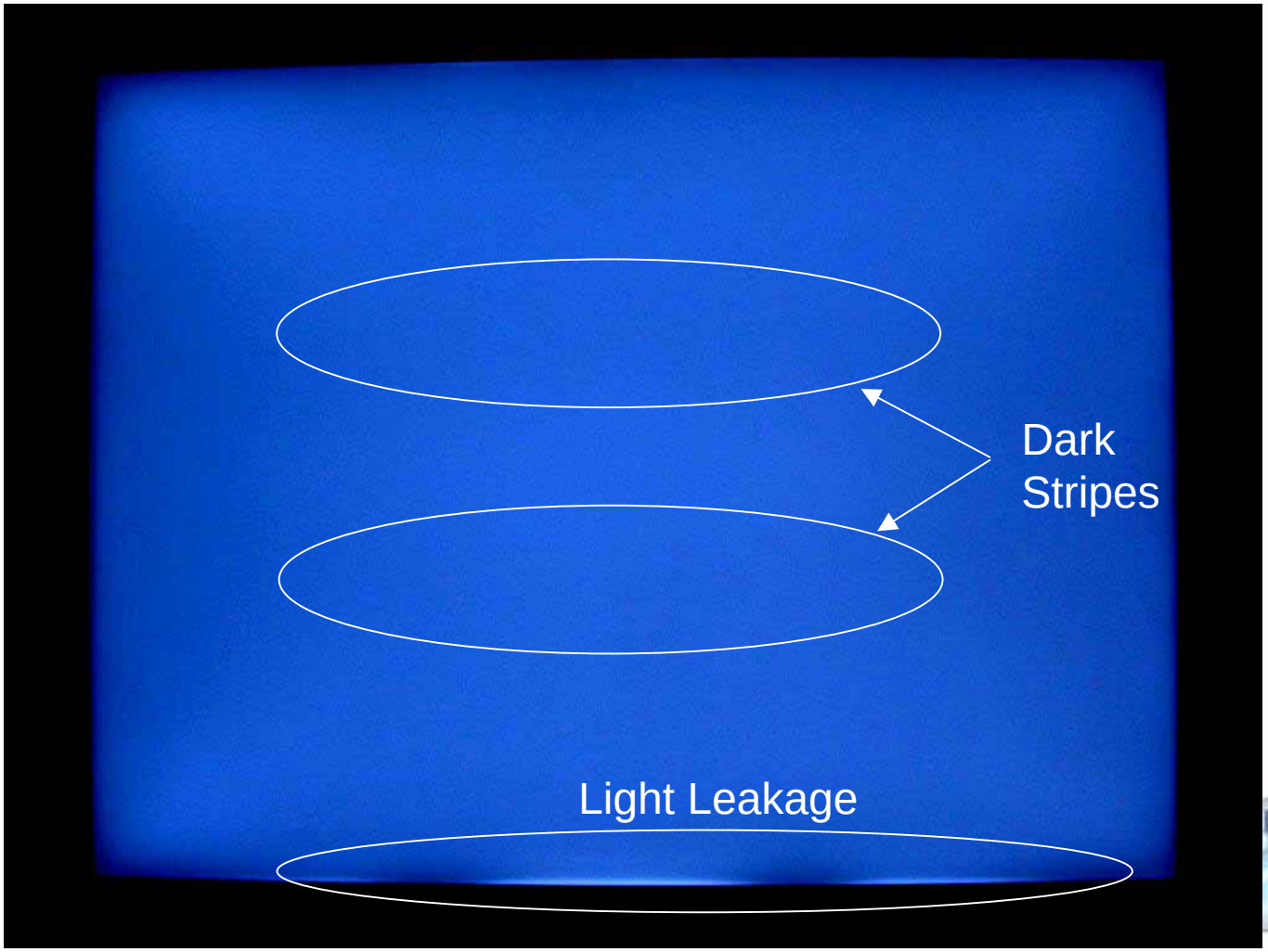
$$\text{Nonuniformity} = 100\%\frac{L_{max} - L_{min}}{L_{max}} = 100\%\left(1 - \frac{L_{min}}{L_{max}}\right)$$

資料來源：

台灣平面顯示器材料與元件產業協會
Taiwan Flat Panel Display Materials and Devices Association
TDMDA

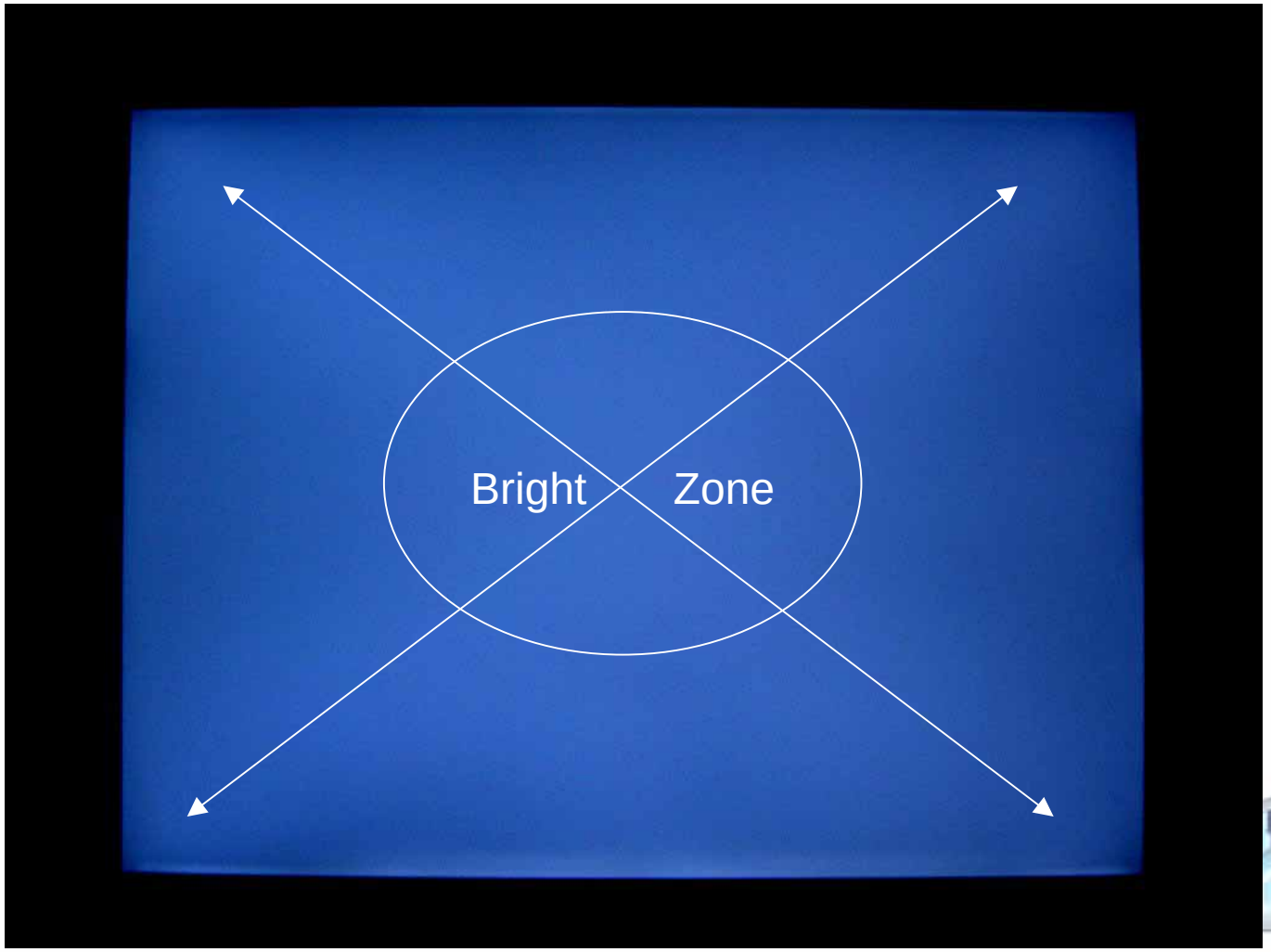
Copy Rights Reserved © 2005

背光源的畫面品味 – 1



Copy Rights Reserved © 2005

背光源的畫面品味 – 2

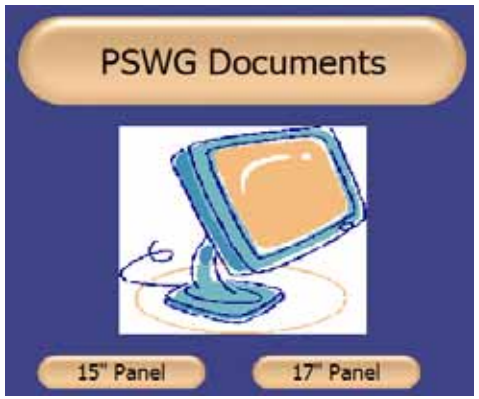


Copy Rights Reserved © 2005

平面顯示器材料與元件的規格

1931
1960
1964

V3.5
Note PC



Monitor

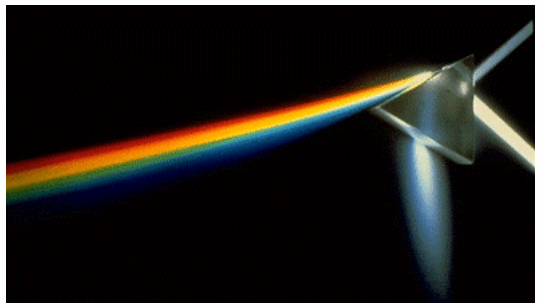
V2.0
Jun'01

台灣平面顯示器材料與元件產業協會
Taiwan Flat Panel Display Materials and Devices Association
TDMDA

Copy Rights Reserved © 2005

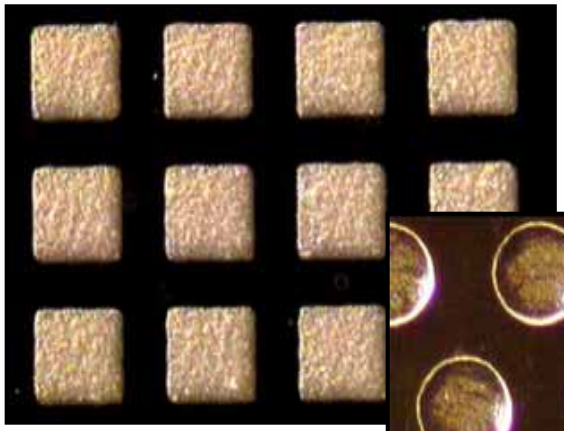
課程大綱

- 背光模組的角色及功能
- 光源與色彩
- 背光模組的組成與光學
- 背光模組的規格與量測
- 背光模組的發展及挑戰
- Q & A



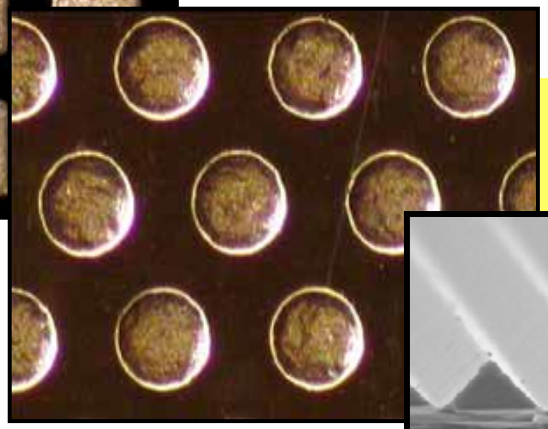
Copy Rights Reserved © 2005

Light-Guide Pattern & Efficiency Gain



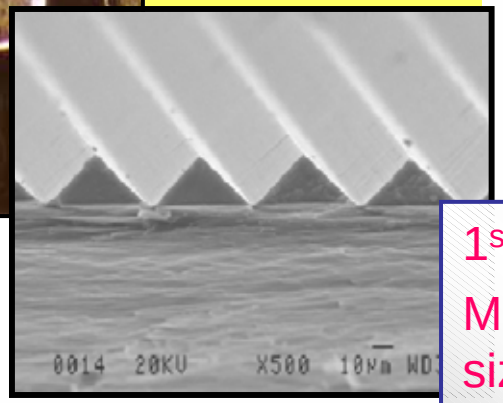
LGP with
Printed Pattern

Linear Optics → Non-linear Optics



Increase 30%
Luminance

vs. LGP with Embossed
Pattern by Injection Molding



Increase 50%
Luminance

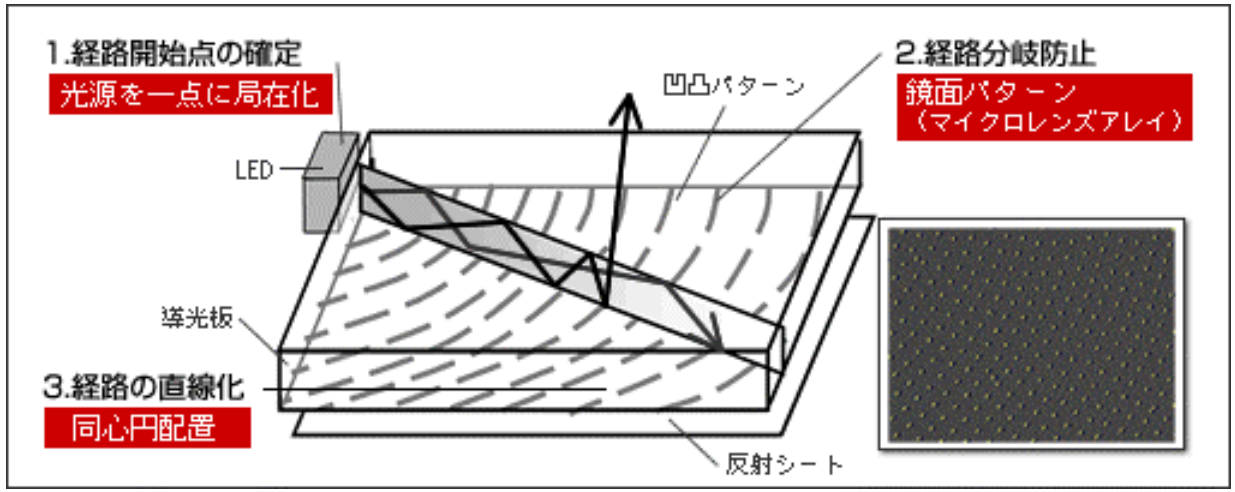
vs. LGP with V-Grooves
by Injection Molding

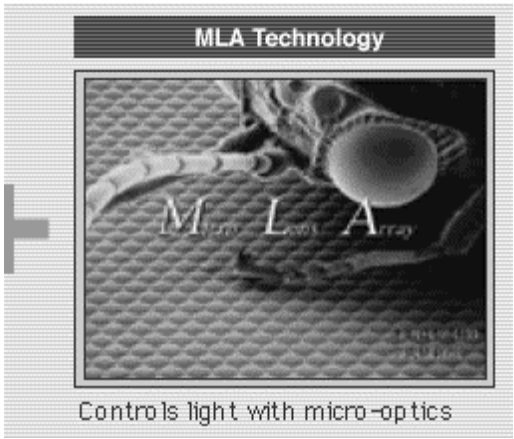
1st step:
Micro-pattern for small size (Mobile Device)

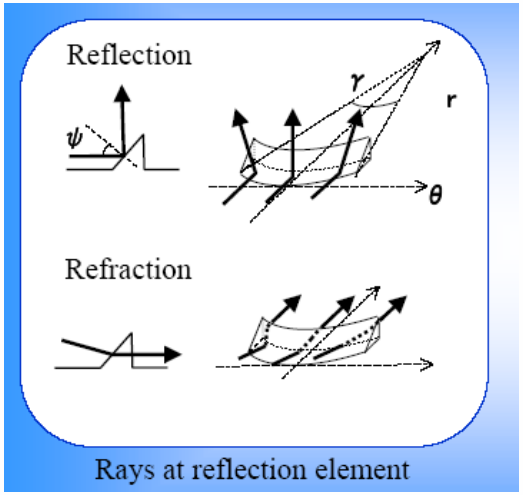
2nd step:
Scale up for Larger size (NB/Monitor/TV)

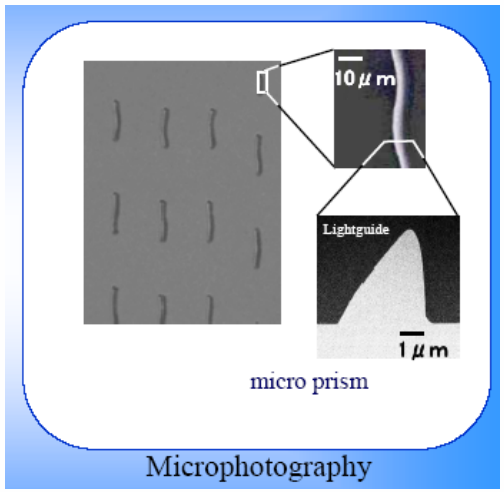
Copy Rights Reserved © 2005

高輝度背光模組 -- 微結構導光板





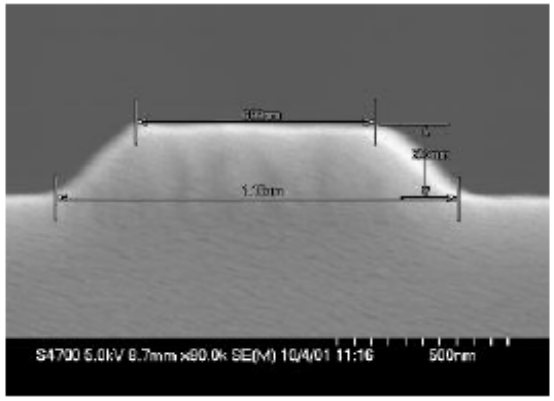


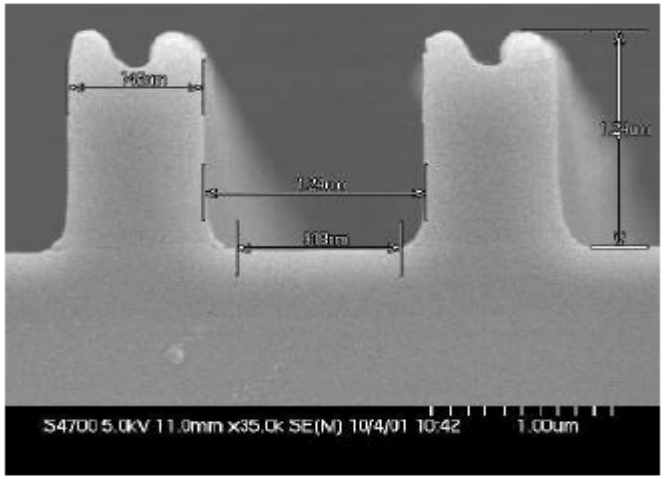


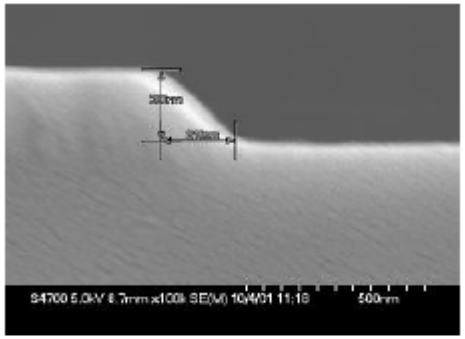
圖片來源：

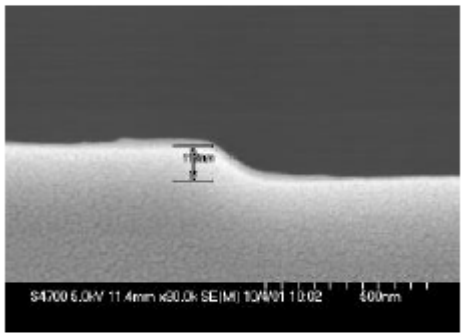
Copy Rights Reserved © 2005

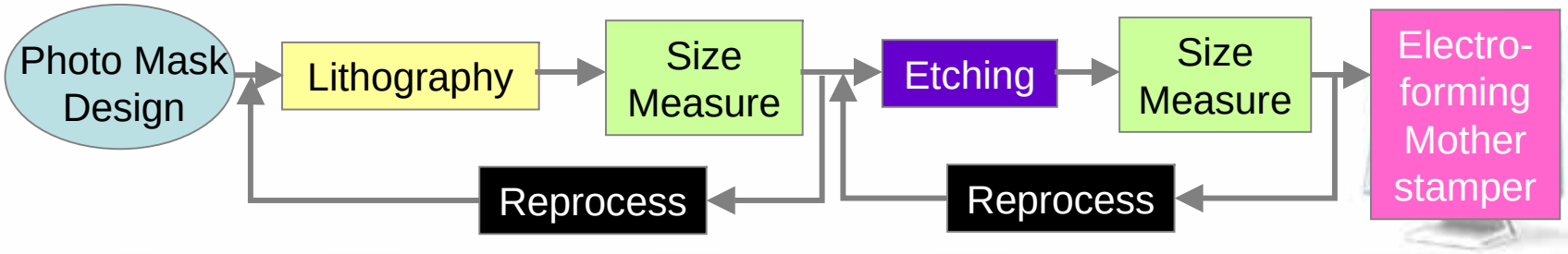
微機電製程→光學原模





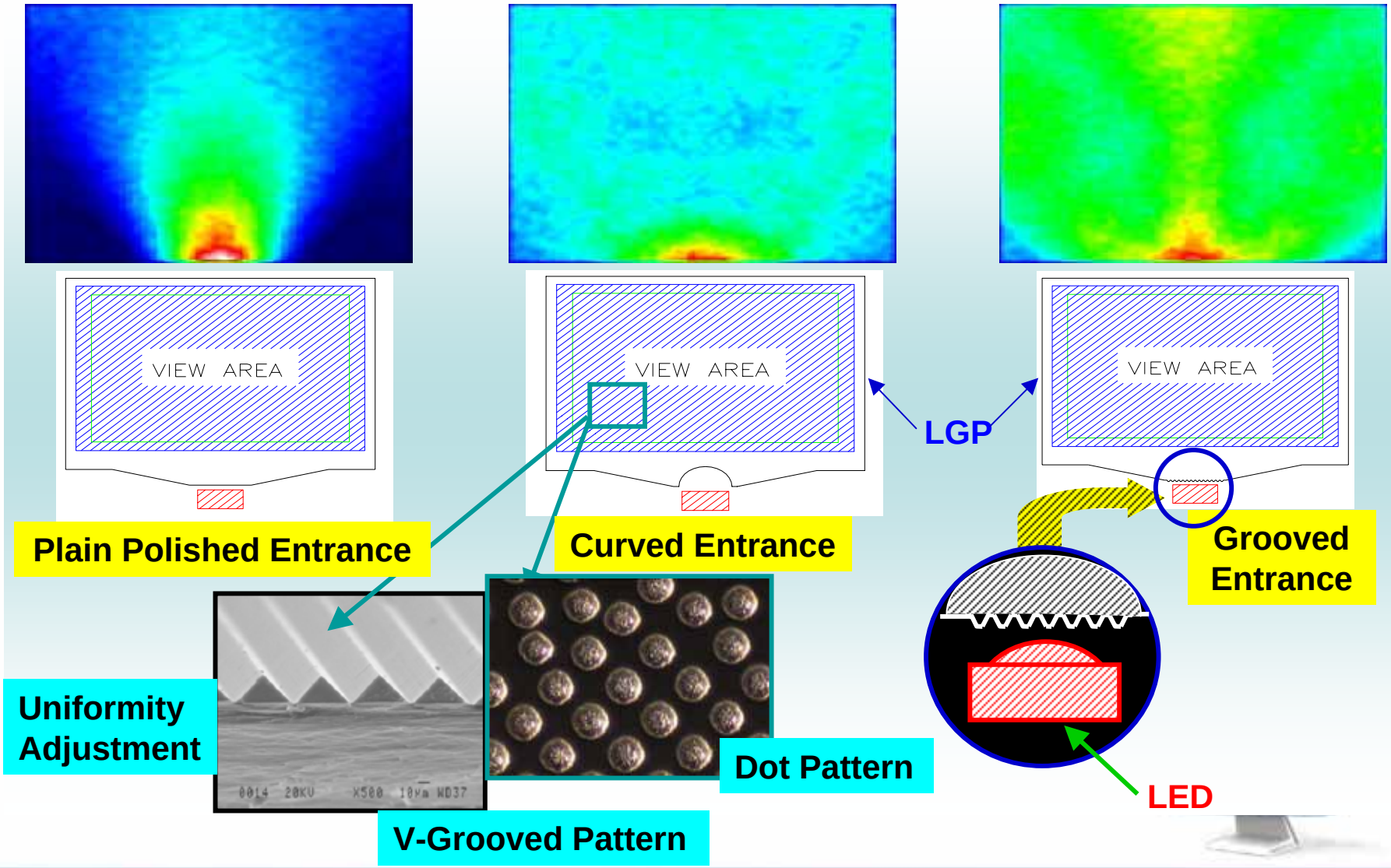






Copy Rights Reserved © 2005

Light Dispersion Mechanism



Copy Rights Reserved © 2005

Advantages of LED BL

- High color gamut achievable with RGB;
- Direct DC driving, no inverter;
- Low driving voltage, thus low EMI;
- Full range dimming or auto-dimming achievable;
- Instant turn on light (< 50 ns);
- Winter-proof applications possible;
- Proof to mechanical vibrations and shocks;
- Slim package possible;
- Improved light entrance efficiency to light guide achievable;
- Mercury free and Lead free.

Copy Rights Reserved © 2005

Design Dilemmas of LED BL

- Color mixing mechanism (RGB Chips)
- Inconsistent variation of RGB chip intensity to temperature (color mixing issue)
- Inconsistent life decay rate of RGB chips (color mixing issue)
- LED driving and compensation technology
- Brightness and Uniformity
- Heat dissipation issues
- cost

Copy Rights Reserved © 2005

Technical Dilemmas of LEDs

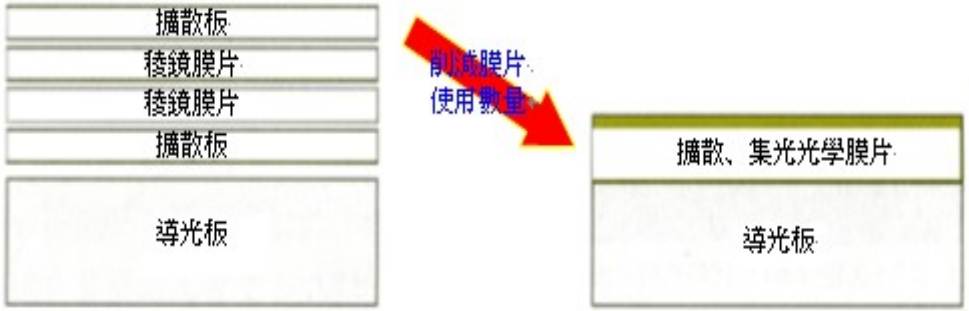
- R G B LED spectrum
- Lifetime: decay and chromaticity shift
- Search for suitable RGB phosphors (single chip)
- Bin stability: luminous intensity and chromaticity
- Energy conversion efficiency (lm/W) not ideal
- Power consumption and Heat dissipation
- Uncontrolled chromaticity shift with temperature (most critical with single-chip & phosphor type)
- Package design → increase luminance gain
- Cost

Copy Rights Reserved © 2005

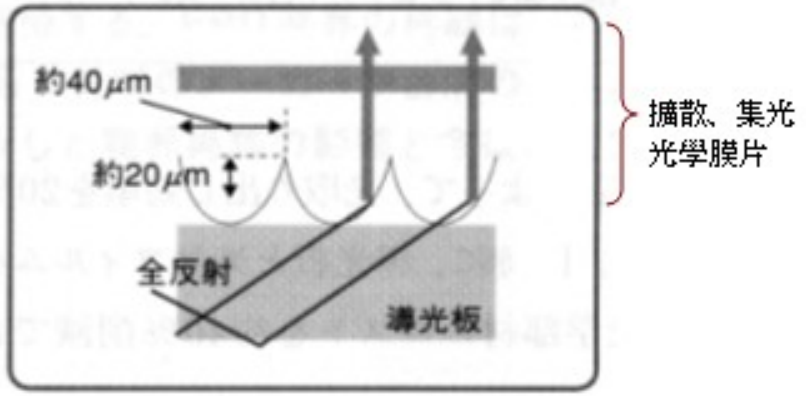
整合型背光模組

--減少元件、增加光學效率--

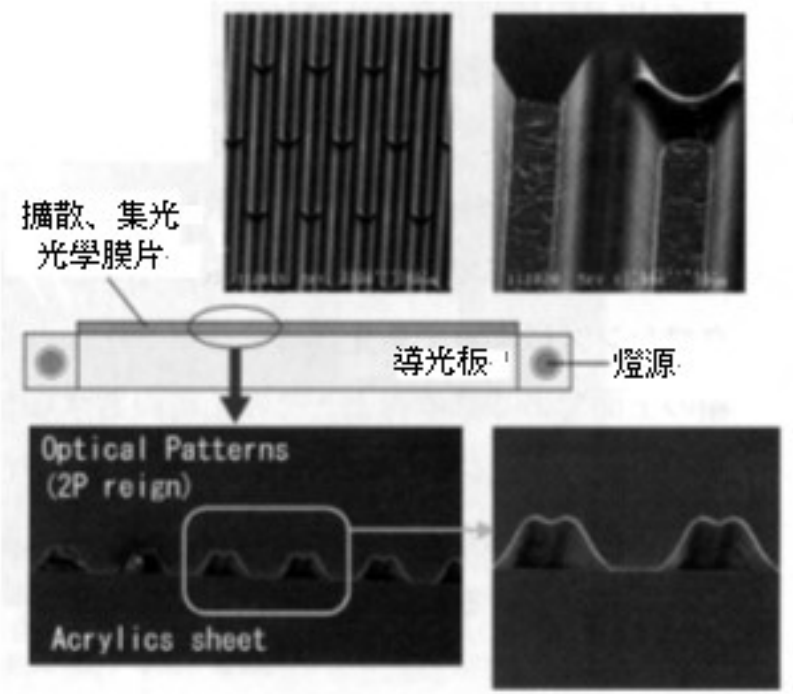
整合型背光模組



(a)削減光學膜片的方法



(b)新型光學膜片的構造

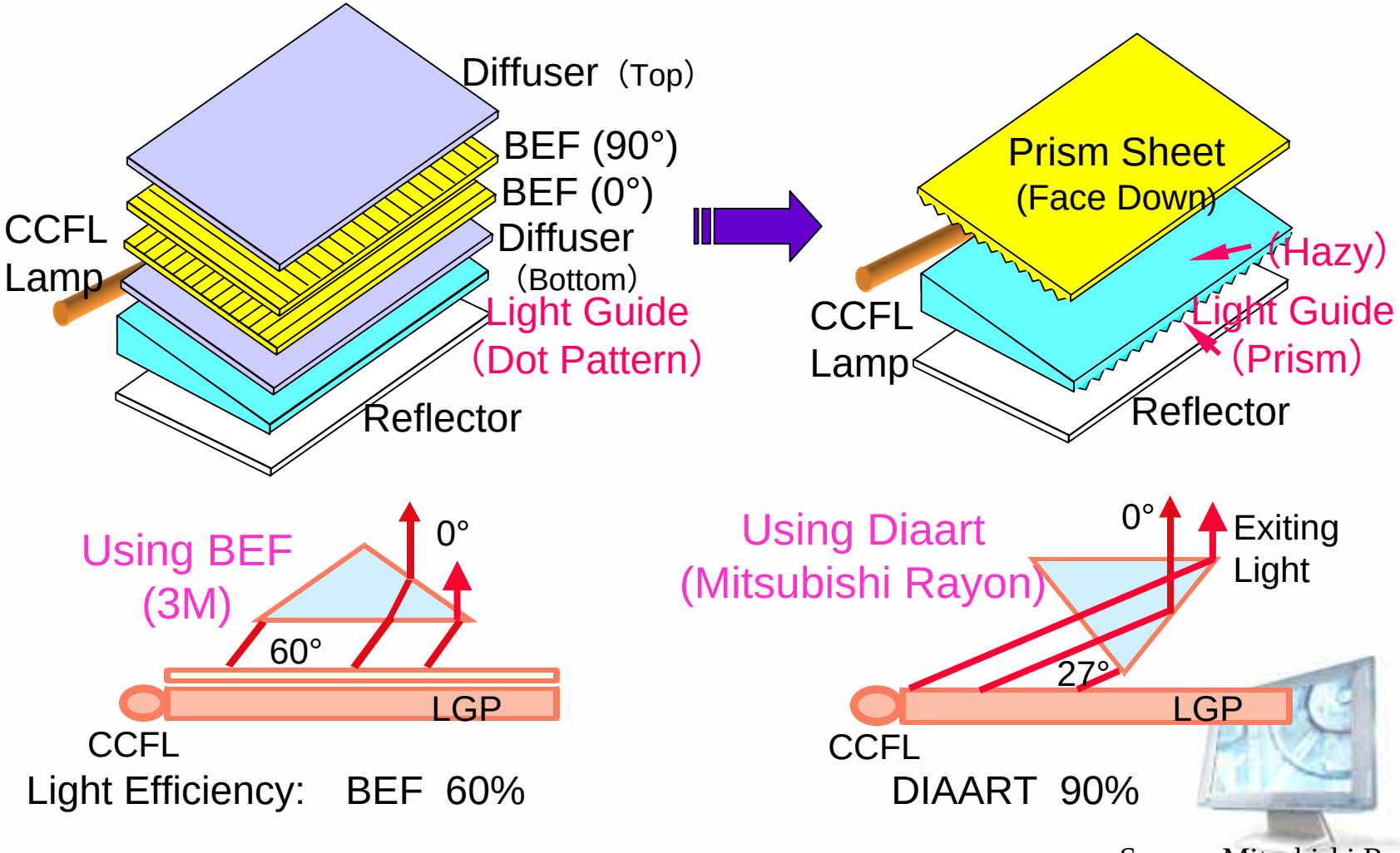


(c)U型微鏡片

資料來源：

Copy Rights Reserved © 2005

Example: Brighter but Fewer Parts with Complex Optical Components



Source: Mitsubishi Rayon

Copy Rights Reserved © 2005

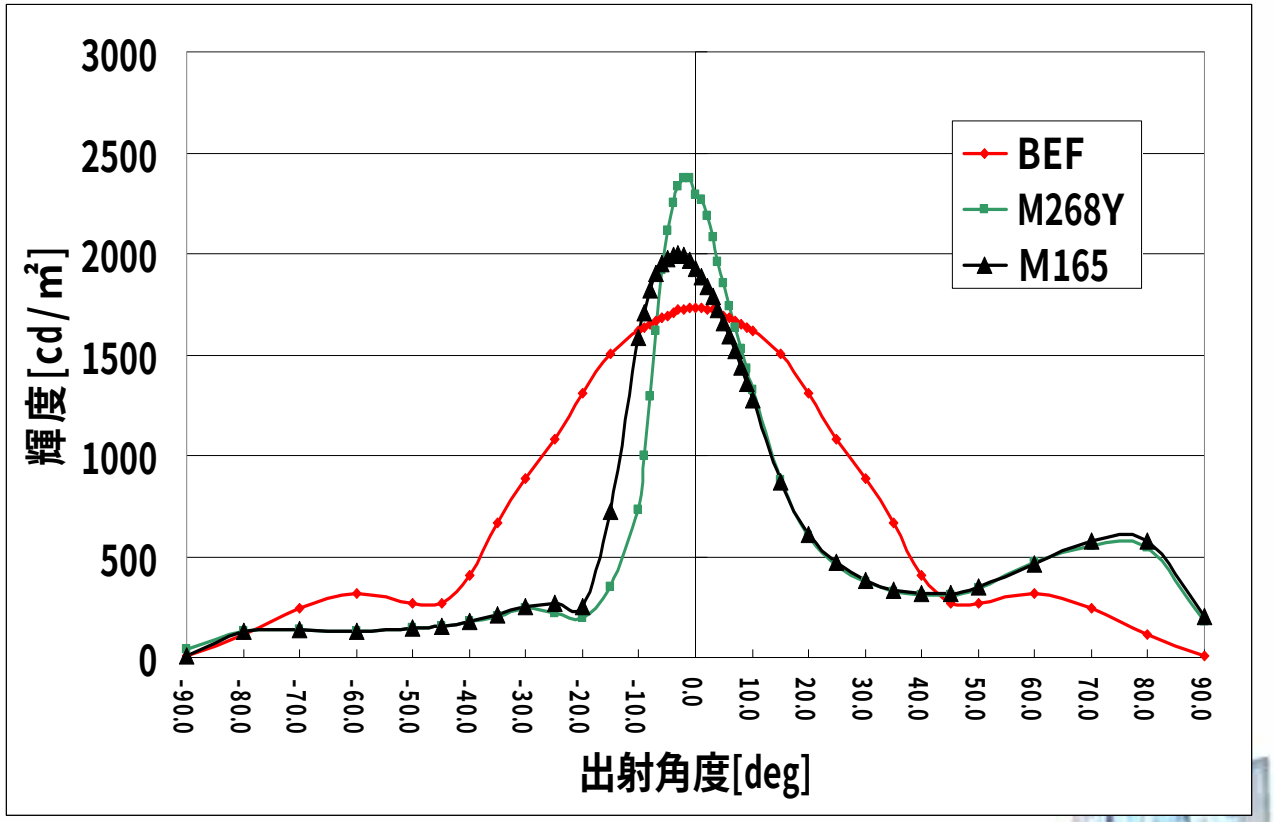
集光片的增光效益與視野角比較

中央點垂直燈管方向

紅線：
3M BEF 二枚

黑線：
M165 ＋ 逆集光導光板

綠線：
M268Y ＋ 逆集光導光板



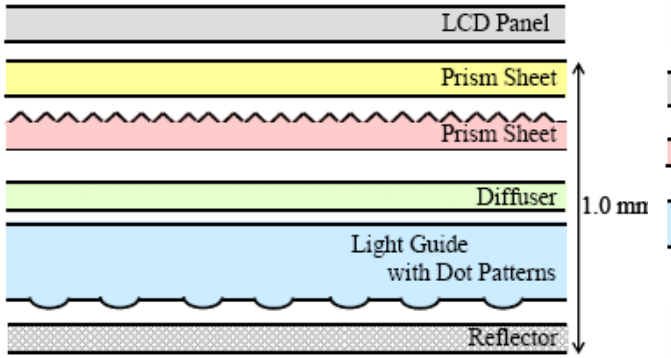
14.1" NB 背光模組、1燈管　　*反射片: E60L

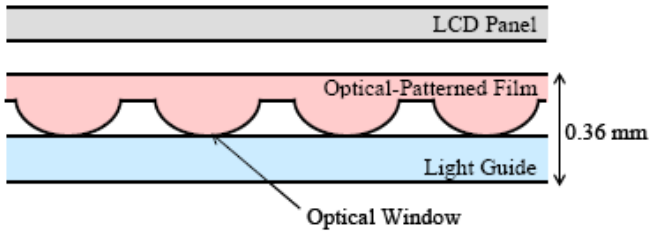
Source: 三菱 Rayon

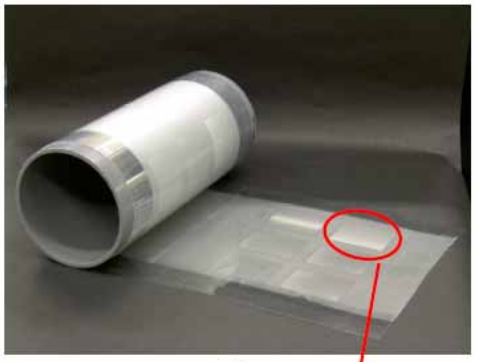
Copy Rights Reserved © 2005

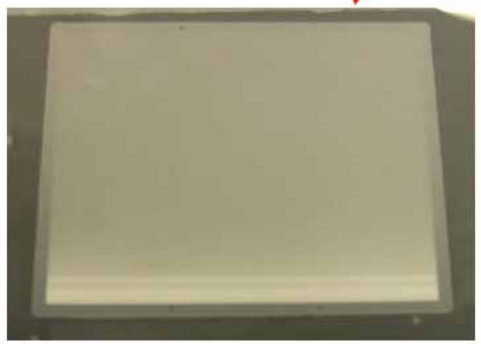
Roll-to-Roll Production

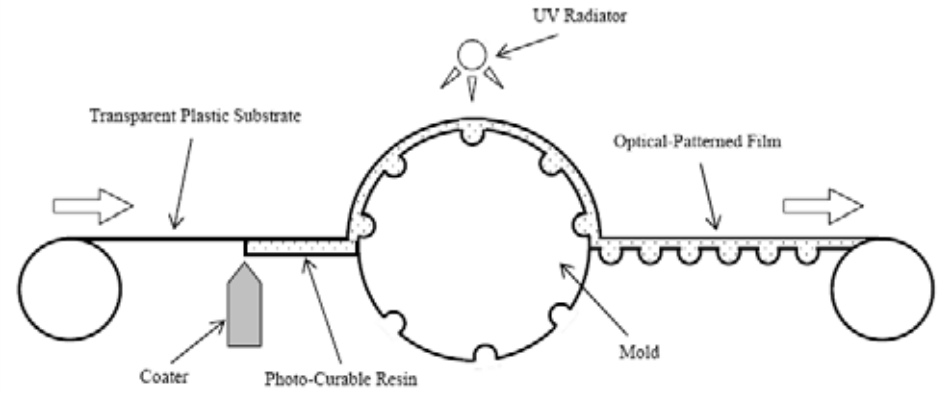
整合型背光模組











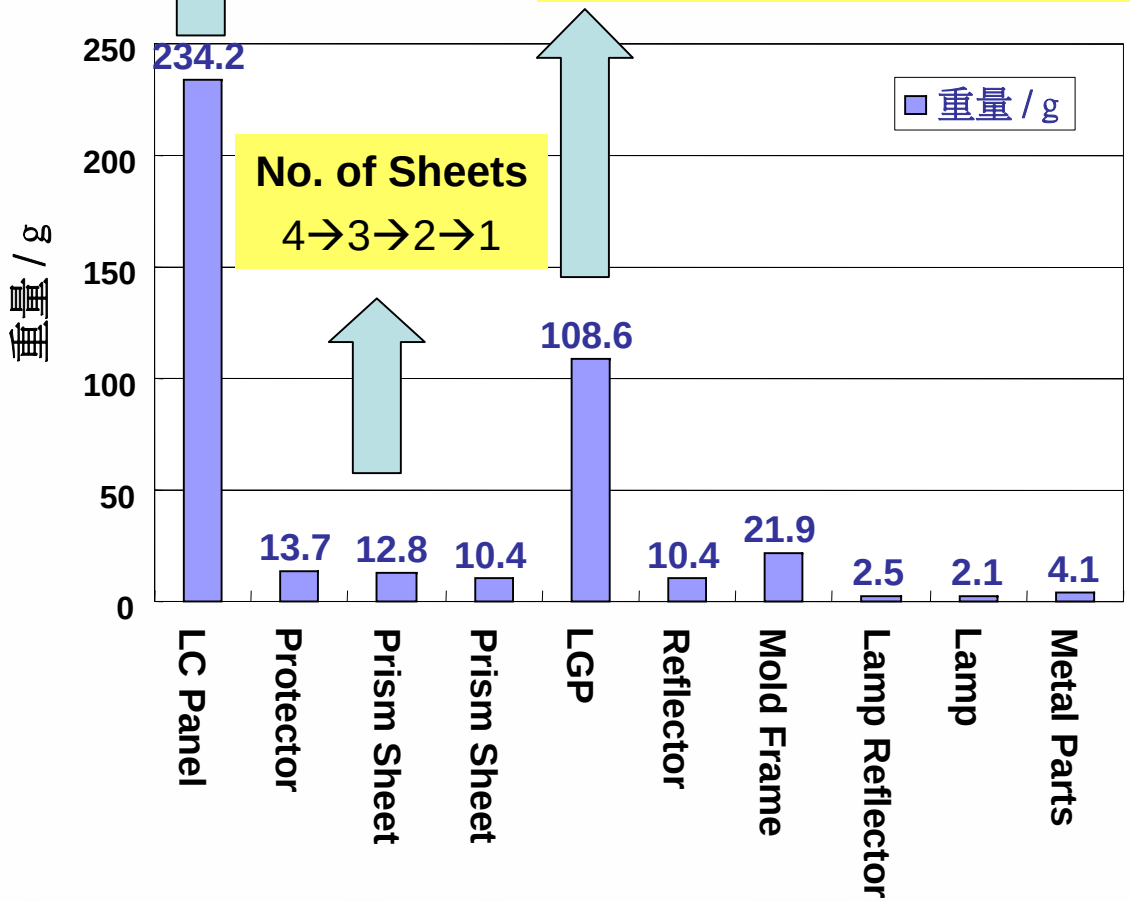
資料來源：次世代モバイル用表示材料技術研究組合
Technology Research Association for Advanced Display Materials (TRADIM)

Copy Rights Reserved © 2005

NB Backlight Road Map – Weight & Thickness

Glass Thickness
0.7 → 0.63 → 0.5 → 0.3 mm

LGP
Thickness ex) 2.4/0.8 → 2.1/0.6 mm → LGP for LED
Material PMMA → COP



No. of Sheets
4→3→2→1

Year 2002
Total 420 g
@ 14.1”

Year 2004
Total 350 g
@ 14.1”

Copy Rights Reserved © 2005

PC Monitor Backlight Road Map

Single-Side Patterned LGP + 3 Films

↓

Single-Side Patterned LGP + 2 Films

↓

Double-Side Patterned LGP + 1 Film

↑

Linear Optics & Nonlinear Optics

Copy Rights Reserved © 2005

TV Backlight Road Map

Size under 26":

Option 1 : Edge Light

A. L Type CCFL + High Brightness LGP

B. LED + Micro-patterned LGP

Diffuser

Prism BEF

DBEF

Option 2 : Direct Light

A. U Lamp + Patterned DP + Heat Dissipative Components

B. LED Matrix + Patterned DP + Heat Dissipative Components

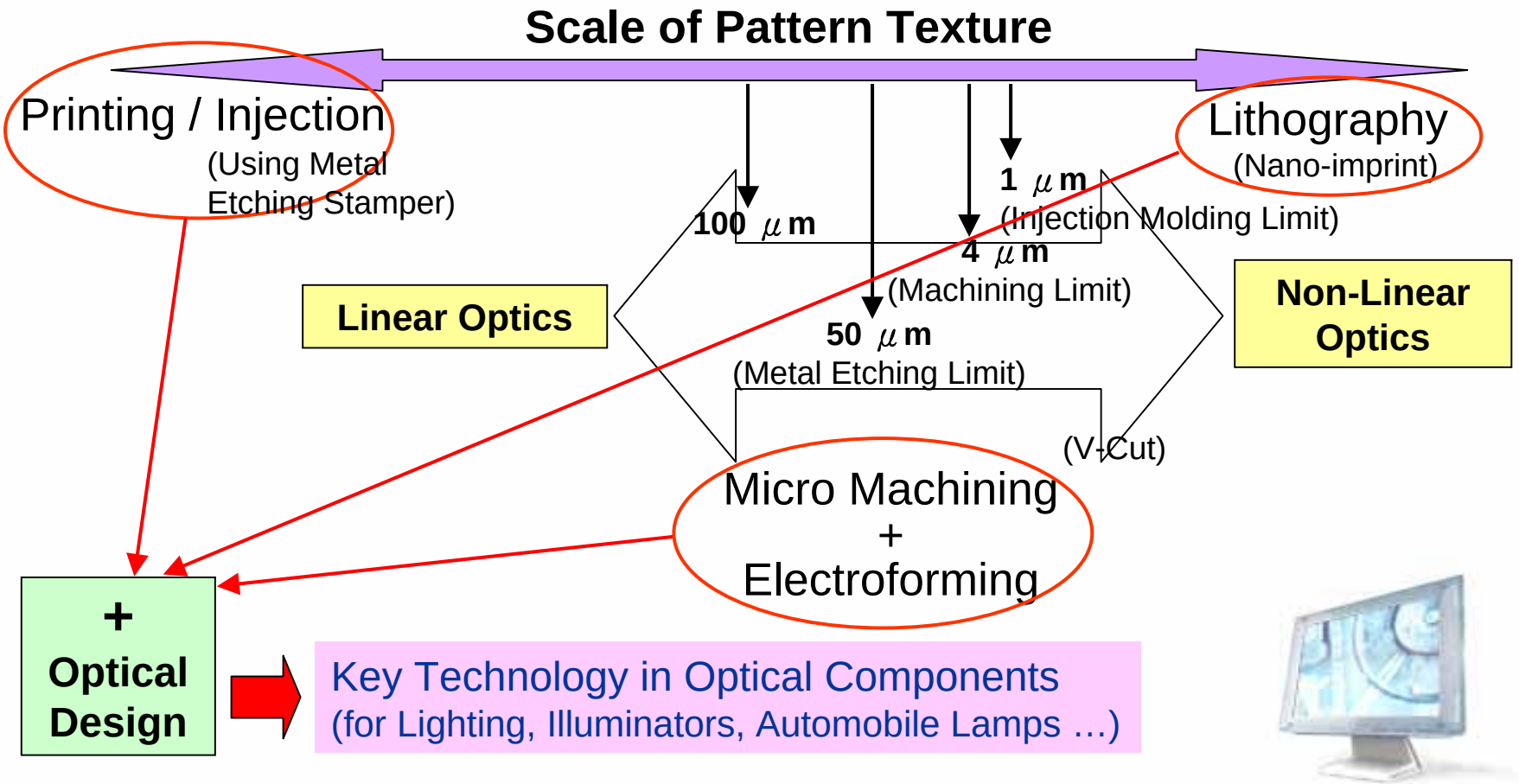
Size over 26":

Direct Light – DP material technology
+ Heat Dissipative Components

Copy Rights Reserved © 2005

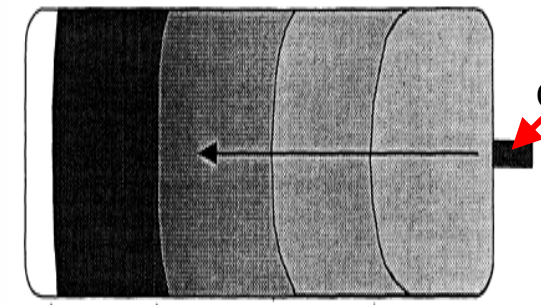
Tooling Technologies and Scale of Optical Pattern

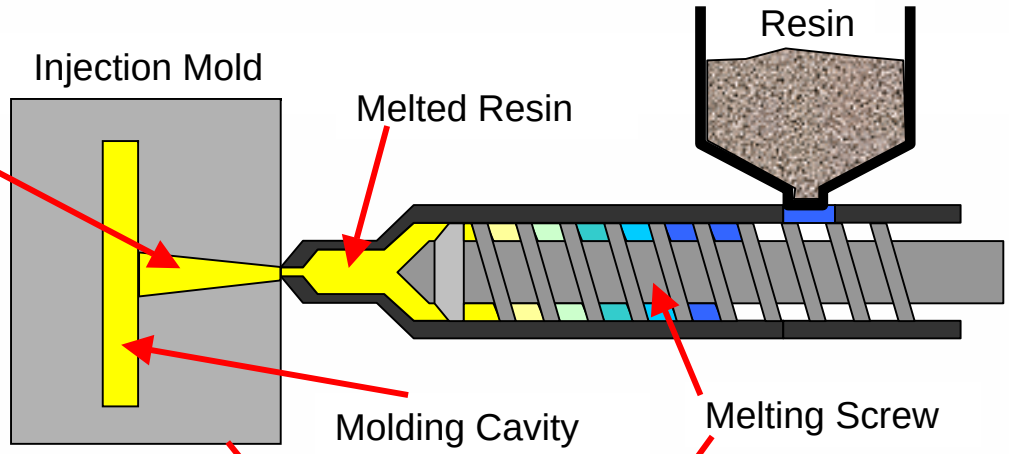
- **Optical pattern defines functional characteristics of LGP/LDP**



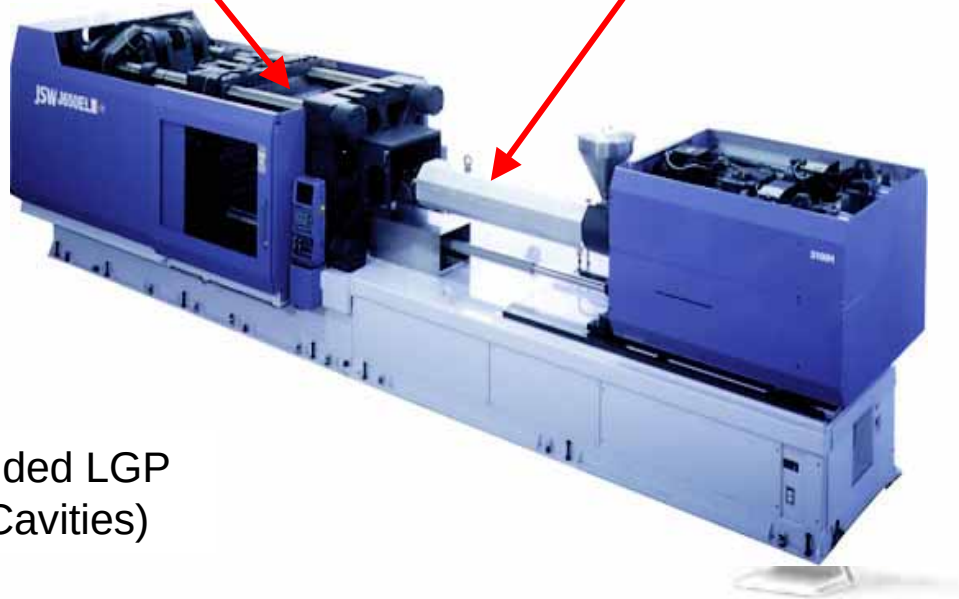
Copy Rights Reserved © 2005

Optical Components by Injection Molding





Molded LGP
(2 Cavities)



Copy Rights Reserved © 2005

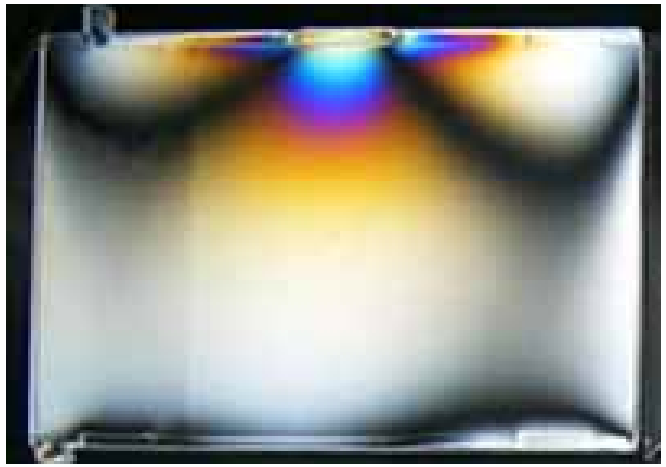
Optical-Graded Resin for LGP Molding

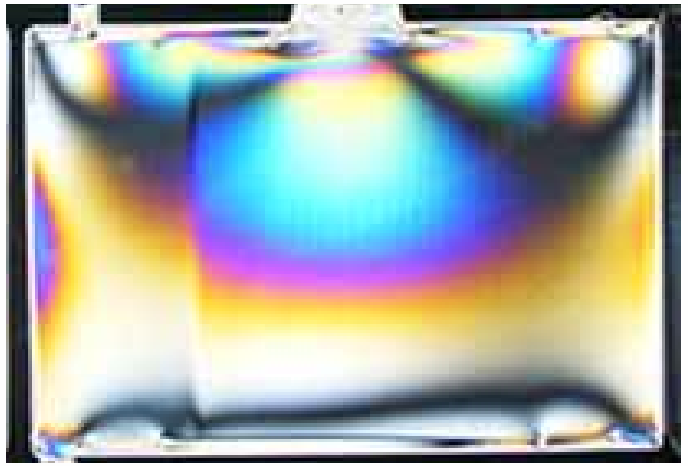
Properties		PMMA	PC	COC/COP
Specific weight		1.2	1.2	1.0
Water absorption rate	%	0.3	0.2	0.01
Transmission rate (visible light spectrum)	@ 3t mm	93%	90%	92%
Index of refraction		1.49	1.59	1.53
Glass transition temp.	T_g (°C)	90~105	145	105
Yellow Index		Better	Worse	Medium

Copy Rights Reserved © 2005

Mold Flow & Internal Stress

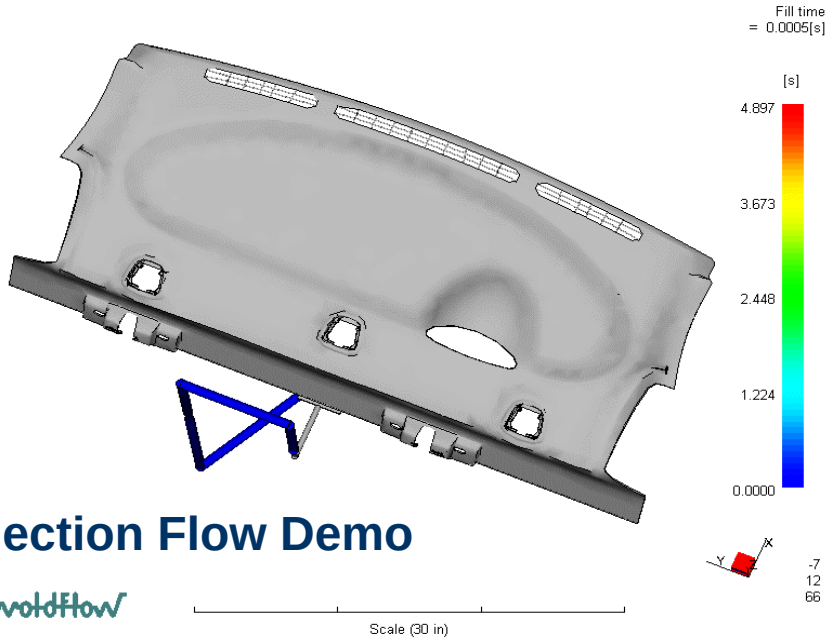
Zeonor





PC

High
Melting
Flow Index
Resin



Injection Flow Demo

Low
Melting
Flow Index
Resin

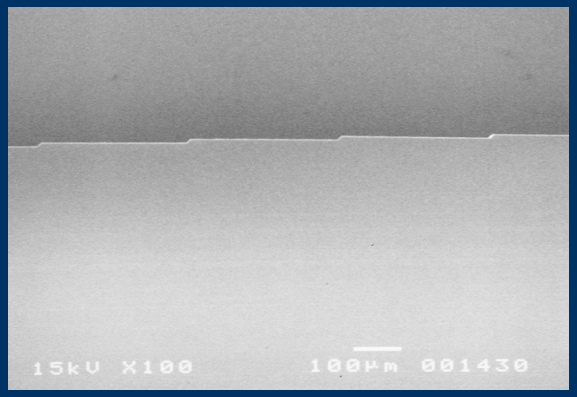
Photo: Nippon Zeon

Copy Rights Reserved © 2005

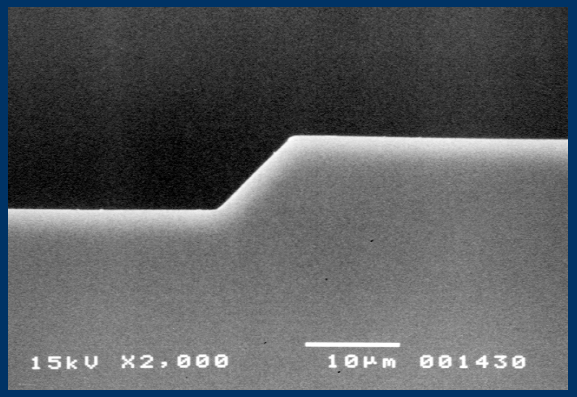
Mold Flow & Pattern Transfer Distortion

High Melting Flow Index Resin

Zeonor

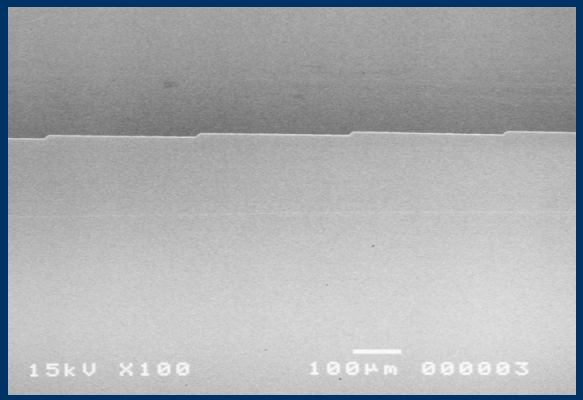


Zeonor



Low Melting Flow Index Resin

PC



PC

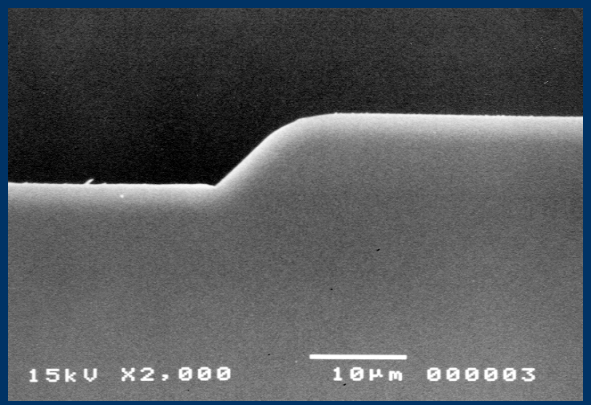
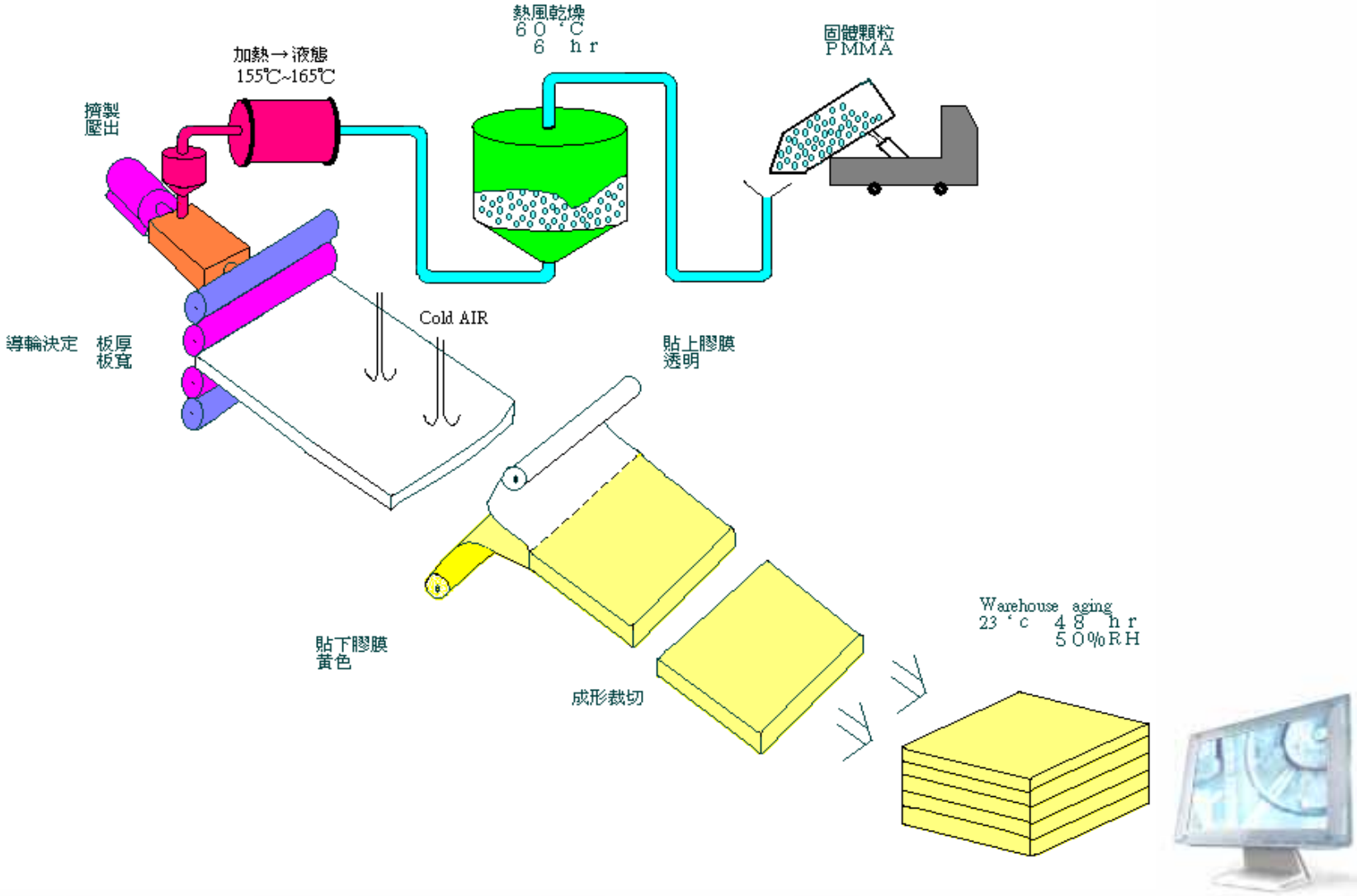


Photo: Nippon Zeon

Copy Rights Reserved © 2005

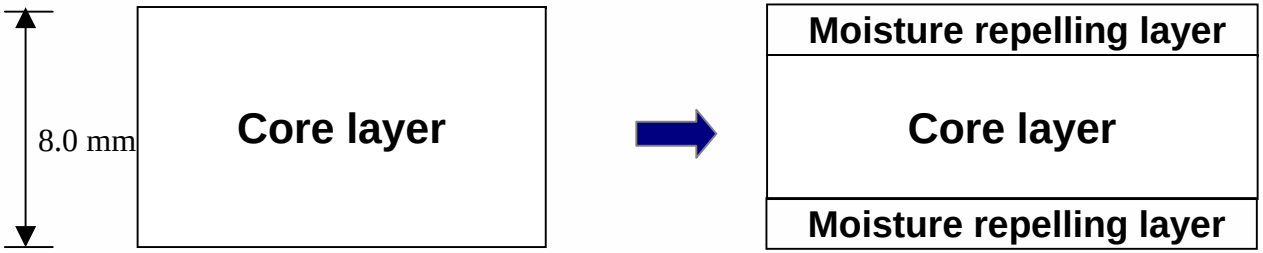
Extrusion Process



Copy Rights Reserved © 2005

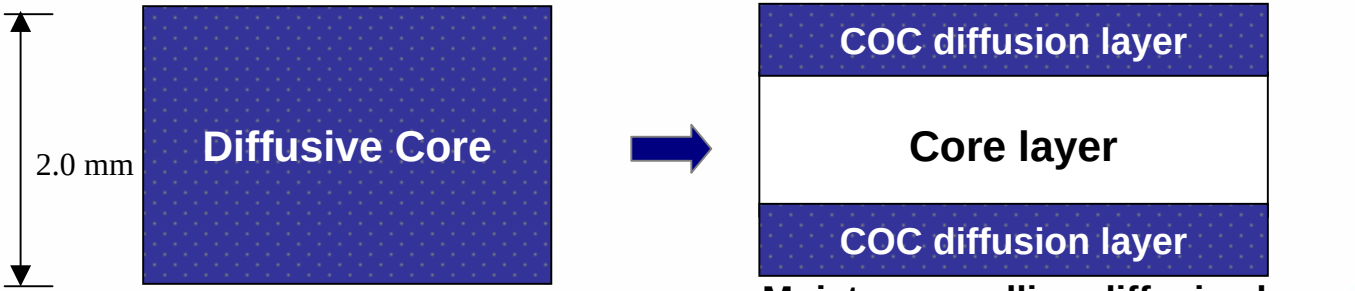
Light Guiding & Light Diffusive Plates

Light-Guide



Conventional LGP　　Composite LGP

Light-Diffuser



Conventional LDP　　Composite LDP

Certain compositions or structures are patented or pending to be patented.

Copy Rights Reserved © 2005

Tough Future – Ambitious Goal

LCD TV Roadmap Call Out….

In year 2005:

30"~40" LCD TV Module @ USD $16 ~ $20 per inch of diagonal size

By year 2008….

30"~40" LCD TV Module @ USD $7 per inch of diagonal size

USD $5 per inch

Copy Rights Reserved © 2005

Technology Development Model

Conventional BL Development Process：

Application → LCD Spec. → B/L Spec. →
Drawing+Component List ⇄ B/L assembler
→ Component Maker

Lack of overall concept for Optimization

Know-How

Material
Optical
Physical+Chemical

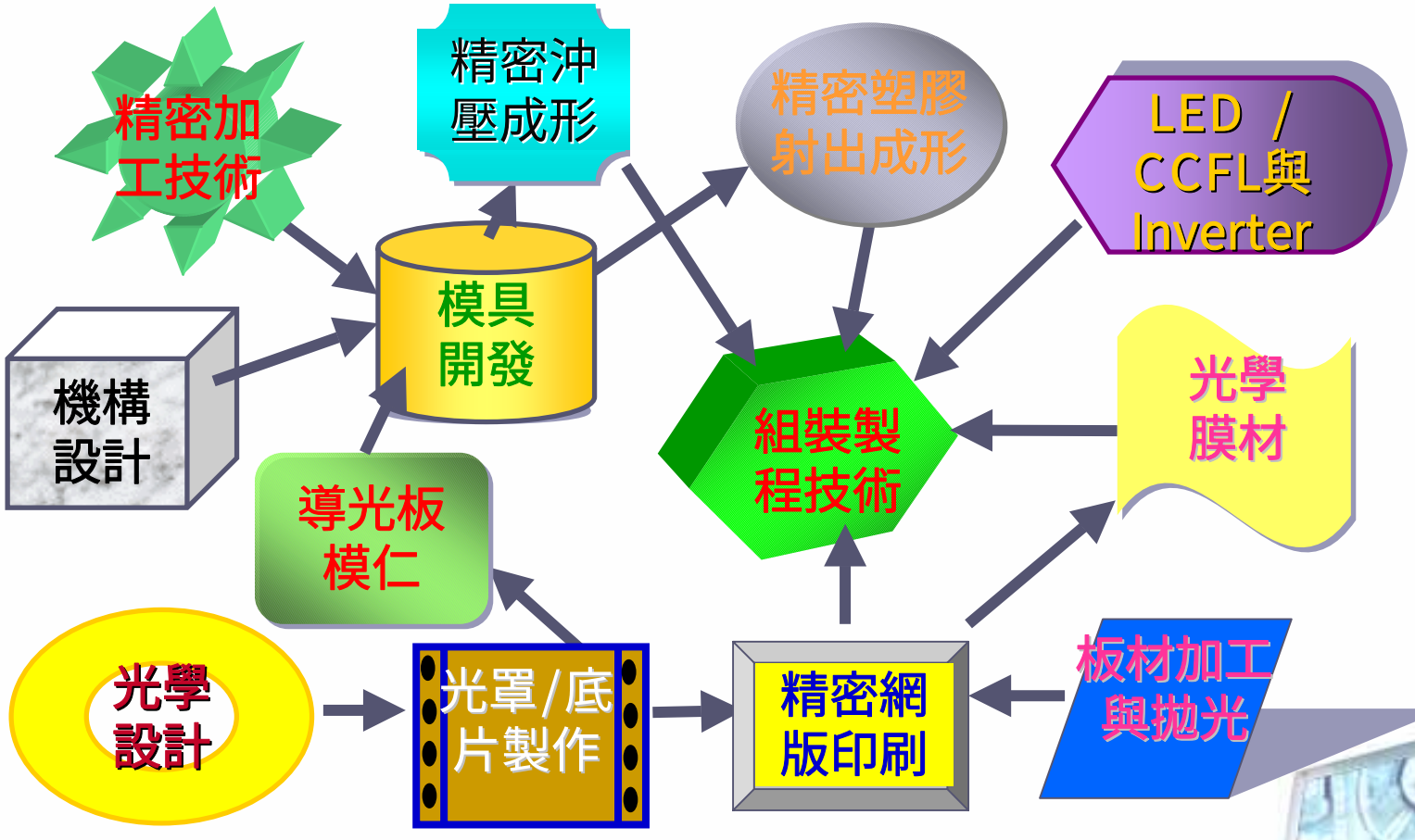
Base on material properties & optical concept

Optimization

Innovated Design Meeting Product Roadmap Requirements

Copy Rights Reserved © 2005

挑戰未來：技術整合



Copy Rights Reserved © 2005

Thank you for your kind attention !!

Q & A

Copy Rights Reserved © 2005