

計畫名稱：應用於 110V 交流電無需變壓器且無需電阻 plug-and-play 之 HVD  
AC LED Module

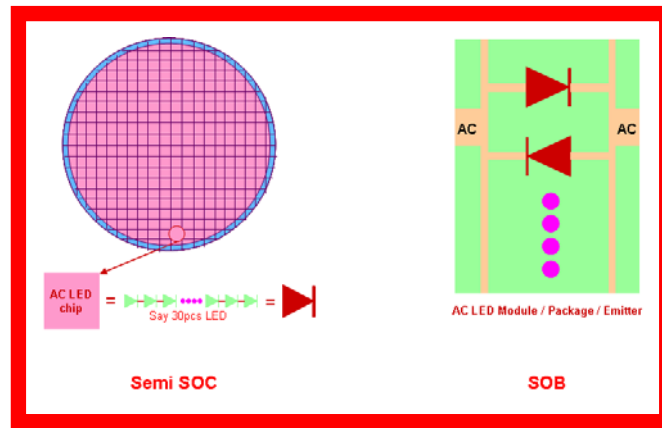
主持人：

一、分項計畫整體願景與目標

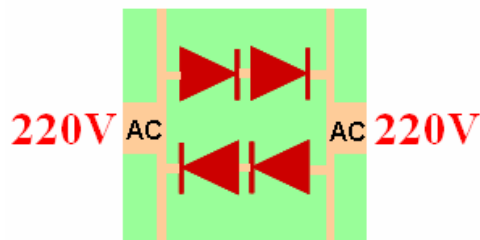
將目前需使用變壓器系統複雜之 DC LED Module 簡化至無需變壓器且無需電阻 plug-and-play 之 HVD AC LED Module。這樣的研發投入，未來可以省去變壓器之成本、省去變壓器之組裝、省去變壓器之維修、省去變壓器之耗電、省去變壓器之安裝空間、省去電變壓器之教育、且 low power factor 之變壓器，電流從電廠傳送至家庭用戶時，會在數百公里長傳送電纜線上產生大量的電力損耗。所以我們的願景與目標是要製作出無需變壓器、無需電阻、省電、high power factor、系統簡單、價格便宜、無需維修、無需安裝變壓器空間、plug-and-play 之 HVD AC LED Module。

此 HVD AC LED Module 可取代 DC LED Module 與變壓器的功能，快速導入 LED 指示與 LED 照明的市場與應用，未來若全部使用 HVD AC LED Module，在 2013 年預估會有超過 1000 億台幣的產值。而 AC LED 之應用領域包含探照燈、緊急照明、室內照明、背光、投影機光源、路燈、交通號誌燈、指示燈、廣告刊版、裝飾燈等。

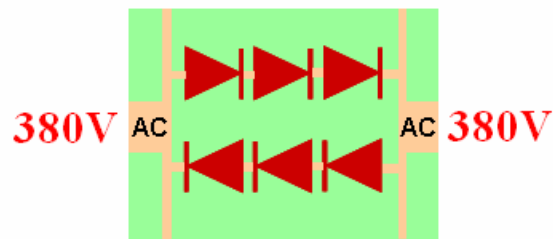
本計劃將使用 IC 製程，將  $\mu$ LEDs 串接，使串接後的  $\mu$ LEDs 元件能耐高電壓、整流並發光。再將串接後的  $\mu$ LEDs 高壓整流發光元件 ( HVLED High voltage Light Emitting Device )，進行順向與逆向固晶、打線封裝，使此封裝體成為可應用於 110V 交流電之 HVD AC LED Module。如附圖一。以此製作方式技術製程比較簡單、良率高且無需加外部電阻。此外，亦可順向串接 2 顆 HVLED 元件、逆向串接 2 顆 HVLED 元件，此 HVD AC LED Module 即可應用於 220V 的交流電源；亦可順向串接 3 顆 HVLED、逆向串接 3 顆 HVLED，此 HVD AC LED Module 即可應用於 380V 的交流電源。如圖二、圖三所示。此技術之最大優點在於使用單一元件，即 110V HVLED，即可運用於 110V 之交流電源、220V 之交流電源與 380V 之交流電源。



圖一、使用 110V HVLED 應用於 110V 交流電之 HVD AC LED Module



圖二、使用 110V HVLED 應用於 220V 交流電之 HVD AC LED Module



圖三、使用 110V HVLED 應用於 380V 交流電之 HVD AC LED Module

### 短程（100 年）：

使用 IC 製程，將藍光 GaN  $\mu$ LEDs 串接，製作出能耐 110V 電壓之整流發光元件(HVLED)。再將藍光 110V 整流發光元件(HVLED)進行順向與逆向固晶、打線封裝，使此封裝體成為可應用於 110V 交流電之藍光 HVD AC LED Module。

將藍光 110V 整流發光元件(HVLED)塗佈螢光粉，製作白光 110V 整流發光元件(HVLED)，使此封裝體成為可應用於 110V 交流電之白光 HVD AC LED Module。

### 中程（101~103 年）：

101 年

使用 IC 製程，將紅光 Semi-insulating AlGaInP  $\mu$ LEDs 串接，製作出能耐 110V 電壓之整流發光元件(HVLED)。再將紅光 110V 整流發光元件(HVLED)進行順向與逆向固晶、打線封裝，使此封裝體成為可應用於 110V 交流電之紅光 HVD AC LED Module。

## 102 年

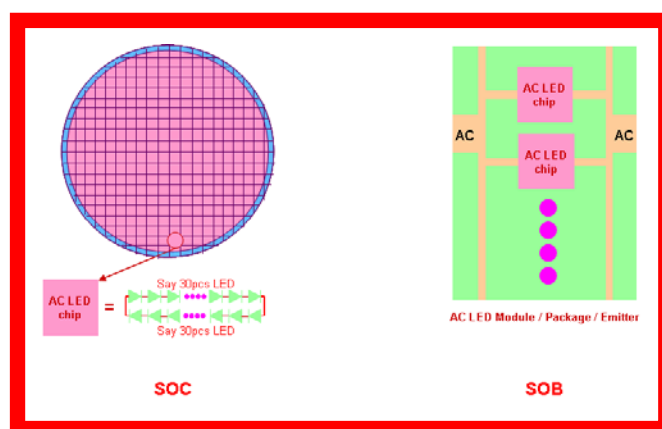
使用 IC 製程，將綠光 InGaN  $\mu$ LEDs 串接，製作出能耐 110V 電壓之整流發光元件(HVLED)。再將綠光 110V 整流發光元件(HVLED)進行順向與逆向固晶、打線封裝，使此封裝體成為可應用於 110V 交流電之綠光 HVD AC LED Module。

## 103 年

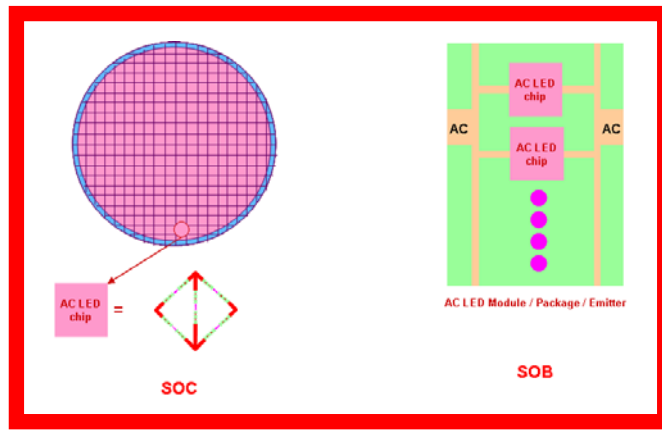
將藍光 110V 整流發光元件(HVLED)、紅光 110V 整流發光元件(HVLED)與綠光 110V 整流發光元件(HVLED)進行順向與逆向固晶、打線封裝，使此封裝體成為可應用於 110V 交流電之白光 HVD AC LED Module。

## 二、各子項計畫國內外技術與關聯產業市場情勢

1. 目前 HVD AC LED Module 有韓國的首爾半導體公司與工研院等在進行研究與產品開發，由於前二單位的技術製程比較困難、良率比較低、需加外部電阻、且不同  $V_f$ (Forward Voltage)之 AC LED chip，不同  $V_f$  之 AC LED chip 所搭配之外部電阻亦不同，增加系統的複雜程度。首爾半導體公司之技術說明圖如圖四。ITRI 之技術說明圖如圖五。



圖四、首爾半導體之 HVD AC LED Module

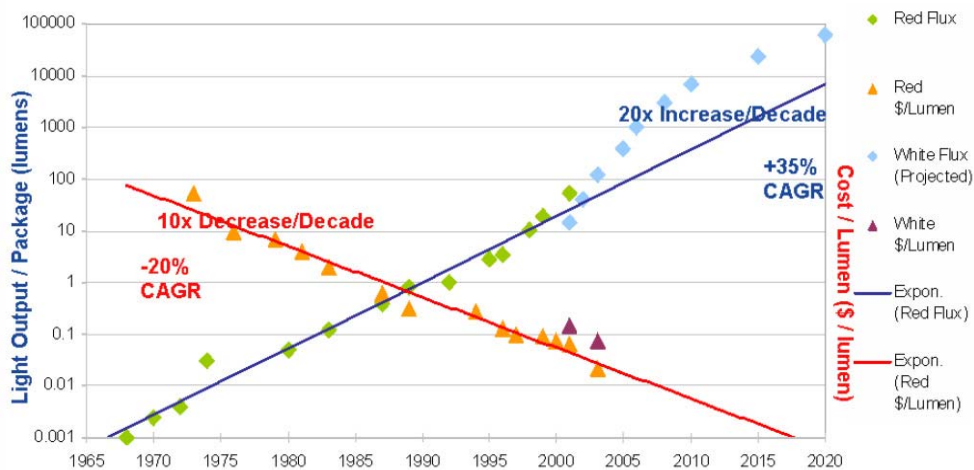


圖五、ITRI 之 HVD AC LED Module

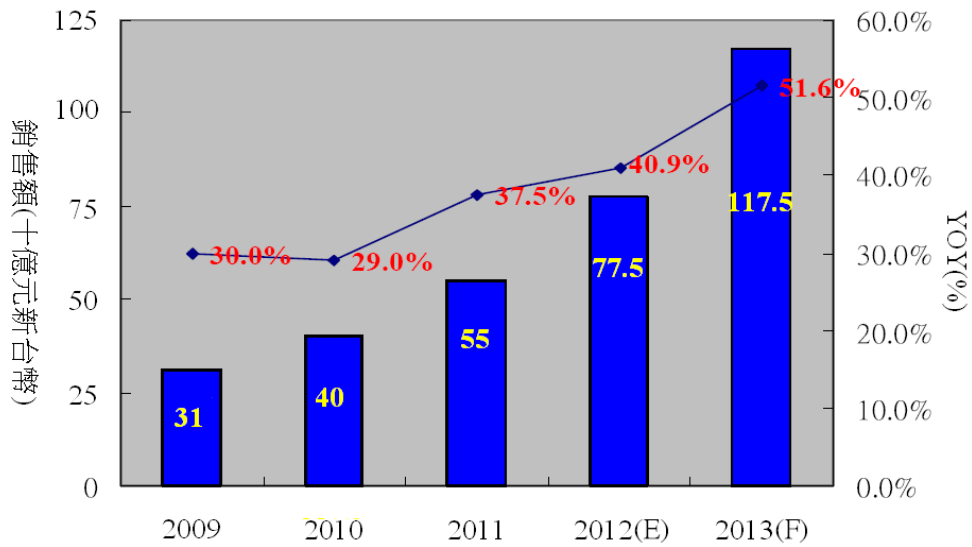
2.

Roland Haitz 提出每 10 年 LED Cost/Lumen 會下跌 10 倍，且 Light Output/Package 則會提升 20 倍。這就是 LED 產業中著名的 Haitz 定律。而 HVD AC LED Module 會加速 Cost/Lumen 下跌的程度。微影的線寬從目前的 7um 縮小至 0.25um，HVD AC LED Module 的 Light Output/Package 會趕上 DC LED module 的 Light Output/Package。考量變壓器的 Power Factor(約 0.65)與 AC LED 的 Power Factor(約 0.95)，從電廠端至用戶端電流經電纜線所消耗的電力，使用 HVD AC LED Module 一定會比使用 DC LED module 省電。因此 HVD AC LED Module 可取代 DC LED Module 與變壓器的功能，快速導入 LED 指示與 LED 照明的市場與應用，未來若全部使用 HVD AC LED Module，在 2013 年預估會有超過 1000 億台幣的產值。

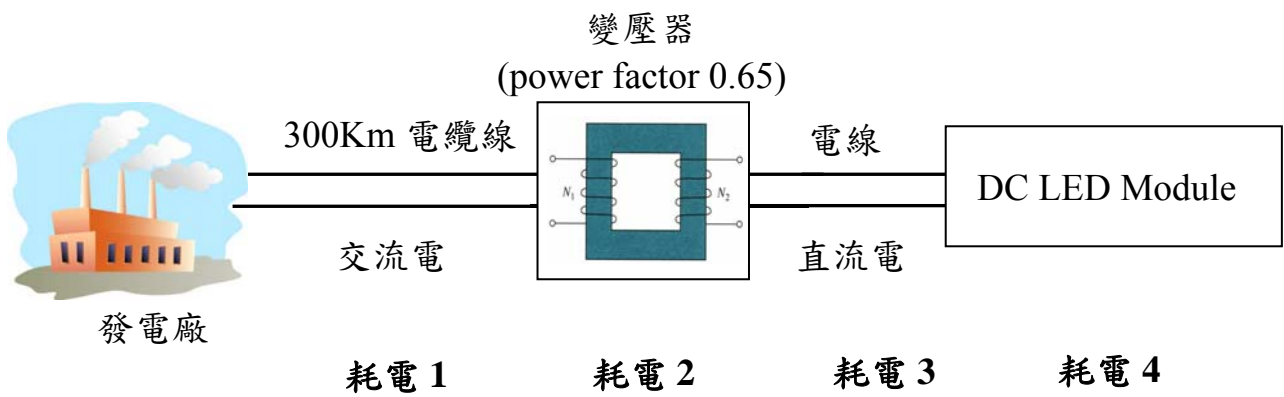
圖六為過去 20 年 DC LED Cost/Lumen 與 Light Output/Package 的趨勢圖。圖七為全球 LED 市場銷售額預測數值。圖八與圖九分別為 DC LED 耗電示意圖與 AC LED 耗電示意圖。



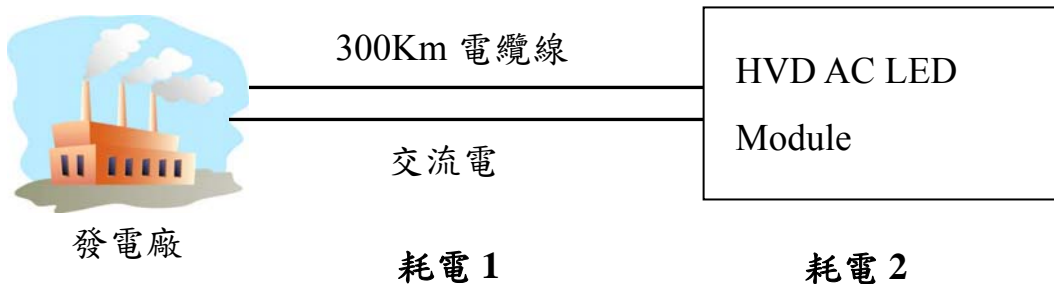
圖六、過去 20 年 DC LED Cost/Lumen 與 Light Output/Package 的趨勢圖



圖七、全球 LED 市場銷售額預測數值



圖八、DC LED 耗電示意圖



圖九、AC LED 耗電示意圖

### 三、各子項計畫技術與關聯產業發展 Roadmap

2010	2011	2012	2013
<p>1. 7um IC 製程，將藍光 GaN <math>\mu</math>LEDs 串接，製作出能耐 110V 電壓之整流發光元件(HVLED)。</p> <p>2. 將藍光 110V 整流發光元件(HVLED) 進行順向與逆向固晶、打線封裝，製作藍光 HVD AC LED Module。</p>	<p>1. 7um IC 製程，將紅光 Semi-insulating AlGaInP <math>\mu</math>LEDs 串接，製作出能耐 110V 電壓之整流發光元件(HVLED)。</p> <p>2. 將紅光 110V 整流發光元件(HVLED) 進行順向與逆向固晶、打線封裝，製作紅光 HVD AC LED Module。</p>	<p>1. 7um IC 製程，將綠光 InGaN <math>\mu</math>LEDs 串接，製作出能耐 110V 電壓之整流發光元件(HVLED)。</p> <p>2. 將綠光 110V 整流發光元件(HVLED)進行順向與逆向固晶、打線封裝，製作綠光 HVD AC LED Module。</p>	<p>將藍光 110V 整流發光元件(HVLED)、紅光 110V 整流發光元件(HVLED)與綠光 110V 整流發光元件(HVLED)進行順向與逆向固晶、打線封裝，使此封裝體成為可應用於 110V 交流電之白光 HVD AC LED Module。</p>

### 四、各子項計畫分年預期成效

可產生全彩之 HVD AC LED Module 與白光 HVD AC LED Module 的指示與照明產品。並可將紅光、綠光、藍光與白光等 HVD AC LED Module 製程技術移轉於晶片廠商與封裝廠商，將帶動超過 1000 億台幣的產值，預估 10 年後可造就第三兆產值的明星產業，讓台灣經濟再起飛。

## **Project : The 110V AC plug-and-play AC LED Module without using adaptor and without using resistor**

### **1. Introduction**

The current DC LED Module is a complicated system with using adaptor. To simplify DC LED Module with using adaptor to the plug-and-play HVD AC LED Module without using adaptor and resistor is the trend in the near future. Thru this state-of-the-art technique, we can save the cost of adaptor, eliminate the lousy adaptor, eliminate the maintenance fee of adaptor 、 reduce the power consumption due to low AC-to-DC conversion efficiency, eliminate the education to customers about adaptor type toward a variety of DC LED package type. In addition, with high power factor(0.95) of HVD AC LED Module, it can reduce the power consumption due to current passing electric cable from a power plant to the home user. This transmitting cable can be hundreds of kilometers long or thousands of kilometers long. Therefore, our vision and goal are to fabricate the plug-and-play, high power factor cheap HVD AC LED Module without using adaptor and without using resistor ◦

This AC LED Module can replace the DC LED Module with lousy adaptor and penetrate into the existing market of DC LED with lousy adaptor, especially in indication and lighting applications ◦ It is estimated that gross output value can reach more than NT\$ 100 billion in year 2013 with good penetration of HVD AC LED Module. This HVD AC LED Module can apply to searchlight 、 emergency lighting 、 indoor lighting 、 backlight module 、 projector 、 street lamps 、 traffic lights 、 indicator 、 billboard 、 fancy lamp and so on ◦

The program will use the IC manufacturing process to fabricate the HVD device , which connect several  $\mu$ LEDs in series to form a high voltage light emitting Device ◦ We call the device High voltage Light Emitting Device ( HVLED) ◦ Then HVLEDs is wired thru anti-parallel methods in a package. This HVD AC LED package can apply to a 110V alternating Voltage. As shown in Fig.1 ◦ By fabricating simple HVD device, this HVD AC LED module can be also used in 220V AC power source and in 380V AC power source ◦ As shown in Figure 2 、 Figure 3 ◦ The major advantage of this technique is that we can apply this HVD AC LED Module in 110V AC, 220V AC, and 380V AC by just manufacturing this 110V HVD Device.

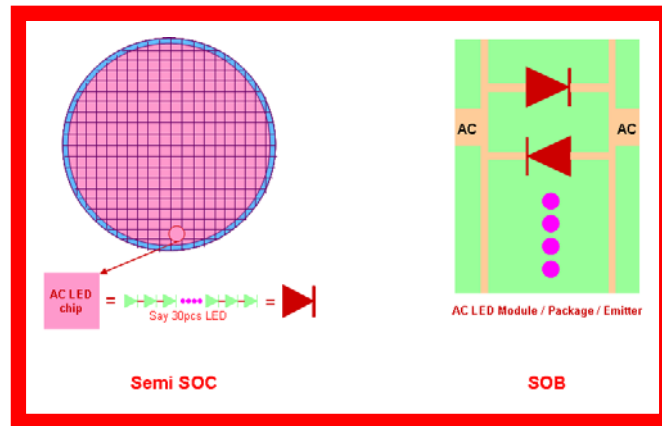


Figure 1 、 110V HVLED applying to 110V AC LED Module

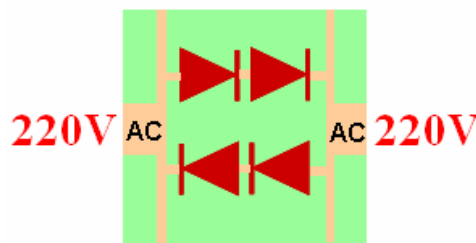


Figure 2 、 110V HVLED applying to 220V AC LED Module

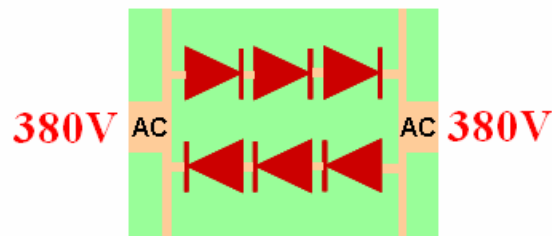


Figure 3 、 110V HVLED applying to 380V AC LED Module

2011 :

Using the IC manufacturing process to fabricate the device , which connect several blue GaN  $\mu$ LEDs in series to rectify 110V AC supply and illuminate blue light . Then the blue-light HVLED proceed in forward and reversely die bonding 、 wire bonding and encapsulation processes , so this package can apply to a 110V alternating current blue-light AC LED Module .

The blue-light 110V AC HVLED coated phosphors to fabricate white-light 110V AC HVLED, so this package can apply to a 110V alternating current white-light AC LED Module .

2012~2014 :

2012

Using the IC manufacturing process to fabricate the device , which connect several Semi-insulating AlGaInP  $\mu$ LEDs in series to rectify 110V AC supply and illuminate red light . Then the red-light HVLED proceed in forward and reversely die bonding 、 wire bonding and encapsulation processes , so this package can apply to a 110V alternating current red-light AC LED Module .

2013

Using the IC manufacturing process to fabricate the device , which connect several InGaN  $\mu$ LEDs in series to rectify 110V AC supply and illuminate green light . Then the green-light HVLED proceed in forward and reversely die bonding 、 wire bonding and encapsulation processes , so this package can apply to a 110V alternating current green-light AC LED Module .

2014

Let blue-light 110V AC HVLED 、 red-light 110V AC HVLED and green-light 110V AC HVLED proceed in forward and reversely die bonding 、 wire bonding and encapsulation processes , so this package can apply to a 110V alternating current white-light AC LED Module .

## **2. Sub-plan about home and aboard technology and related industrial market situation**

- a. The current AC LED Module with Seoul Semiconductor Corporation 、 the Industrial Technology Research Institute (ITRI) and other semiconductor companies are conducting research and product development . For the first two units , the manufacturing process of AC LED chip are more difficult 、 have low yield 、 need additional external resistors and different  $V_f$  (Forward Voltage) of AC LED chips match different external resistors , the above increases complexity of the system . Technical chart of Seoul Semiconductor Corporation is shown in Figure 4 . Technical chart of ITRI is shown in Figure 5 .

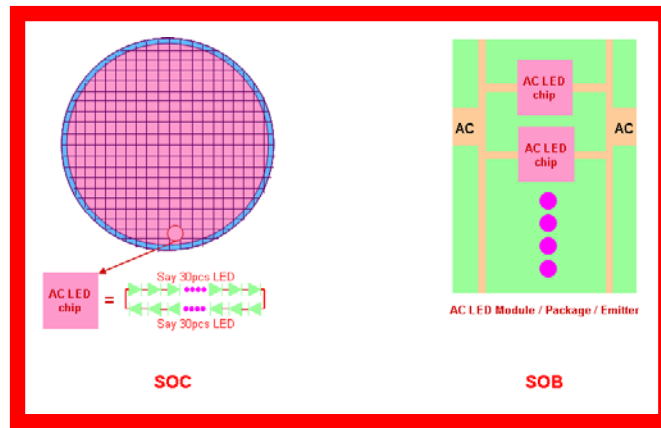


Figure 4 、 AC LED Module of Seoul Semiconductor Corporation

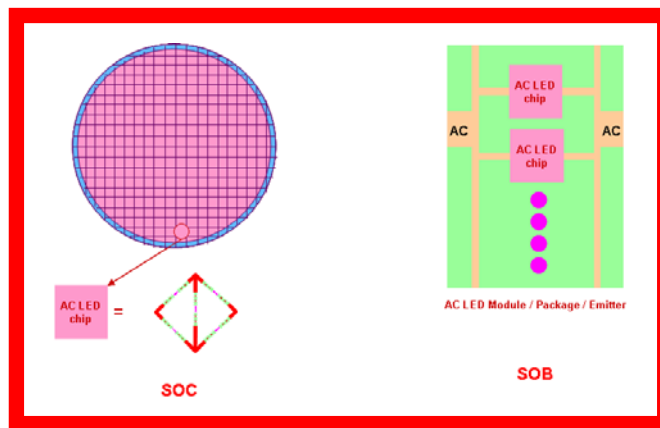


Figure 5 、 AC LED Module of ITRI

b. Roland Haitz states that every decade, the cost per lumen falls by a factor of 10, the amount of light generated per LED package increases by a factor of 20. This is the famous Haitz's Law in the LED industry. The AC LED module will accelerate decrease in Cost / Lumen. If linewidth for optical lithography reduces from  $7\ \mu\text{m}$  to  $0.25\ \mu\text{m}$ , the Light Output / Package of AC LED module will catch up with Light Output / Package of DC LED module. Considering power factor between transformer (about 0.65) and AC LED (about 0.95), the AC LED module is more energy efficient than the DC LED module. This AC LED Module can replace the DC LED Module with transformer and quickly import LED indication and lighting into market and applications. The gross output value of AC LED module industry is expected to exceed NT\$ 100 billion in 2013.

Figure 6 shows the tendency curve for DC LED Cost / Lumen and Light Output / Package for the past 20 years ◦ Figure 7 shows the forecasting sales volume for the global LED market ◦ Figure 8 and Figure 9 show schematic diagrams of power consumption of DC LED and AC LED , respectively ◦

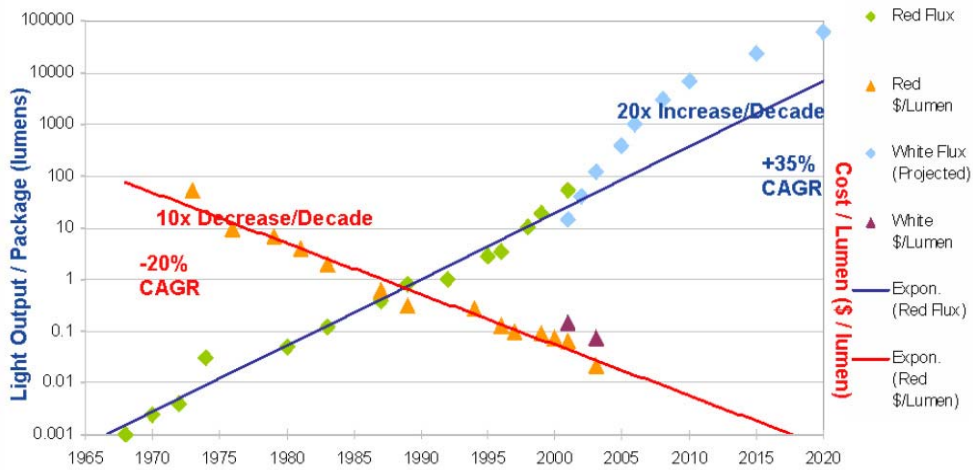
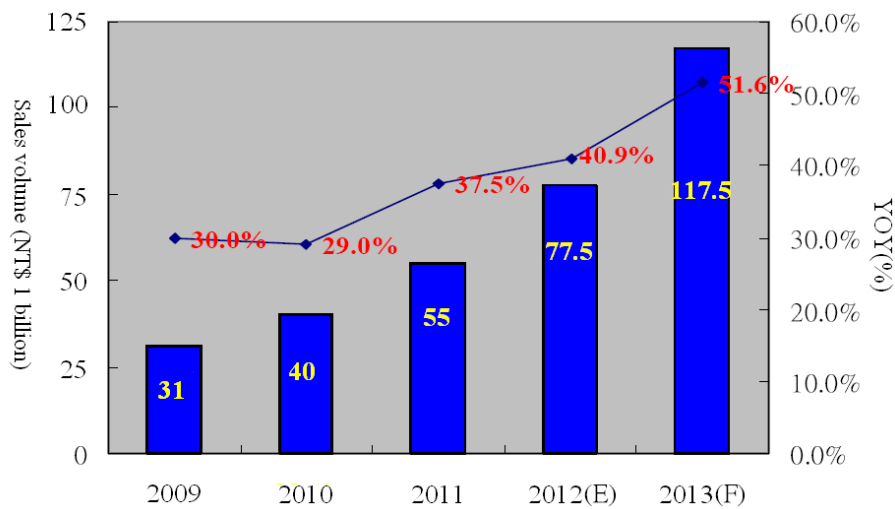


Figure 6、 The tendency curve for DC LED Cost / Lumen and Light Output / Package for the past 20 years



Figure

7、 The forecasting

sales volume for the global LED market

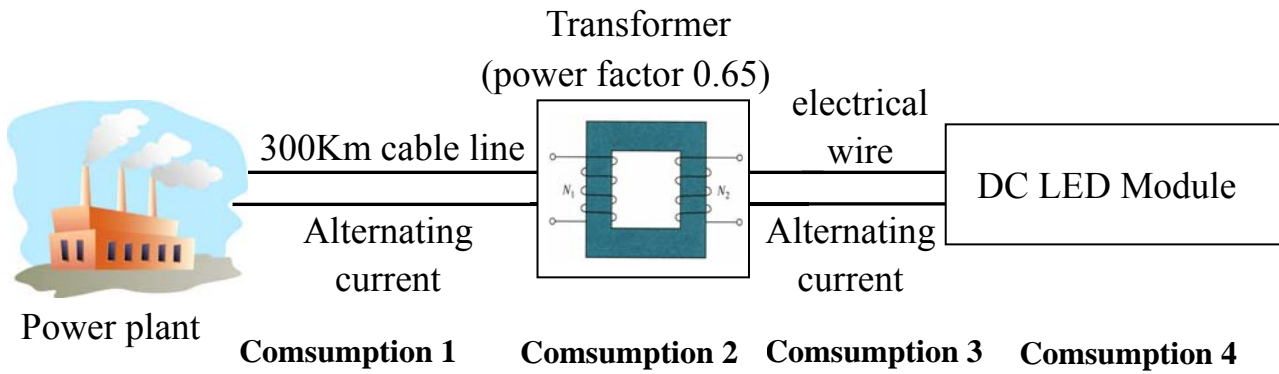


Figure 8 · Schematic diagrams of power consumption of DC LED

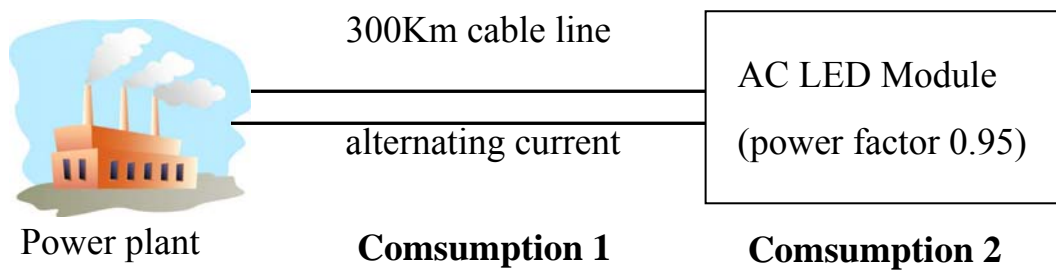


Figure 9 · Schematic diagrams of power consumption of DC LED

### 3. A roadmap for related industrial development and technology of sub-project

<b>2011</b>	<b>2012</b>	<b>2013</b>	<b>2014</b>
<p><b>1.</b> Using the <math>7\mu\text{m}</math> IC manufacturing process to fabricate the device , which connect several blue GaN <math>\mu\text{LEDs}</math> in series to rectify 110V AC supply</p>	<p><b>1.</b> Using the <math>7\mu\text{m}</math> IC manufacturing process to fabricate the device , which connect several red Semi-insulating AlGaInP <math>\mu\text{LEDs}</math> in series to rectify</p>	<p><b>1.</b> Using the <math>7\mu\text{m}</math> IC manufacturing process to fabricate the device , which connect several green InGaN <math>\mu\text{LEDs}</math> in series to rectify 110V AC</p>	<p>Let blue-light 110V AC HVLED 、 red-light 110V AC HVLED and green-light 110V AC HVLED proceed in forward and reversely die</p>

<p>and illuminate blue light ◦</p> <p><b>2.</b> The blue-light HVLED proceed in forward and reversely die bonding 、 wire bonding and encapsulation processes 、 so this package can apply to a 110V alternating current blue-light AC LED Module</p>	<p>110V AC supply and illuminate red light ◦</p> <p><b>2.</b> The red-light HVLED proceed in forward and reversely die bonding 、 wire bonding and encapsulation processes 、 so this package can apply to a 110V alternating current red-light AC LED Module</p>	<p>supply and illuminate green light ◦</p> <p><b>2.</b> The green-light HVLED proceed in forward and reversely die bonding 、 wire bonding and encapsulation processes 、 so this package can apply to a 110V alternating current green-light AC LED Module</p>	<p>bonding 、 wire bonding and encapsulation processes 、 so this package can apply to a 110V alternating current white-light AC LED Module</p>
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#### **4. Expected result of project**

The expected result of project is manufacturing indication and light products of full color and white-light of AC LED module ◦ Then the fabrication technology of red- 、 green- 、 blue- and white-light AC LED module can transfer in the chip and packaging manufacturers 、 the gross output value expect to exceed NT\$100 billion and estimate to create the third star industry(gross output value is above NT\$ 1 trillion) ◦ Let Taiwan's economy took off again ◦