國立中央大學-統新光訊股份有限公司

產學合作計畫書

發光二極體之透明導電薄膜特性與背鍍之膜質材料特性研究分析
計畫結案報告

執行機構：　中央大學 薄膜技術中心

執行期間： 101年8月01日至102年7月31日

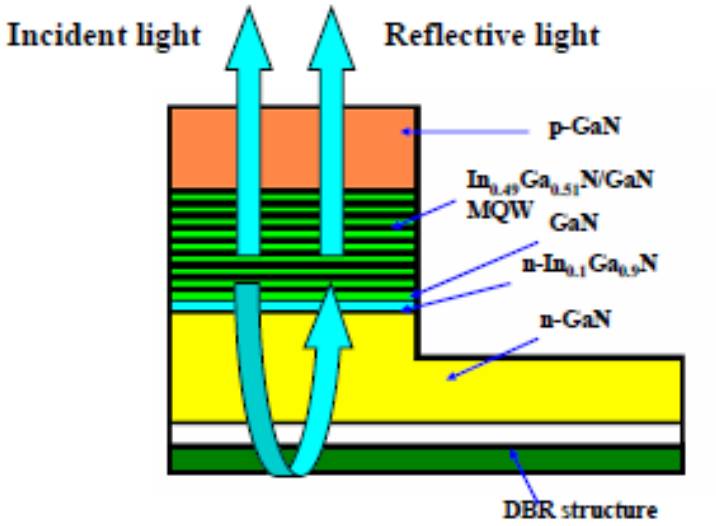
計畫主持人：　李正中
共同主持人：　郭倩丞

Omni-Directional Reflector(ODR) of High Brightness Light Emitting Diode (LED)

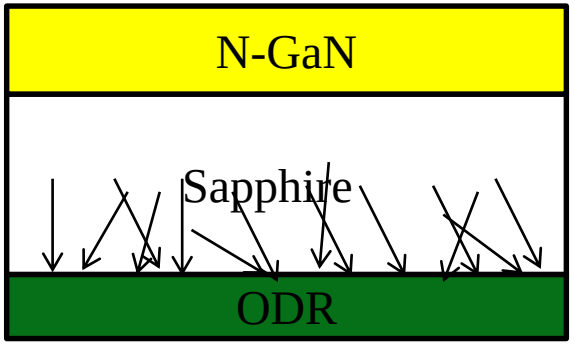
Outline

- LED with ODR
- Compare with Metal and DBR
- Structure of ODR(DBR+Al)
- Sample Design and Result (7layer)
- Compare different layer design
- Thickness error analyze
- DBR with Al/Ag
- Advantage of ion source bombard
- Conclusion

LED with ODR

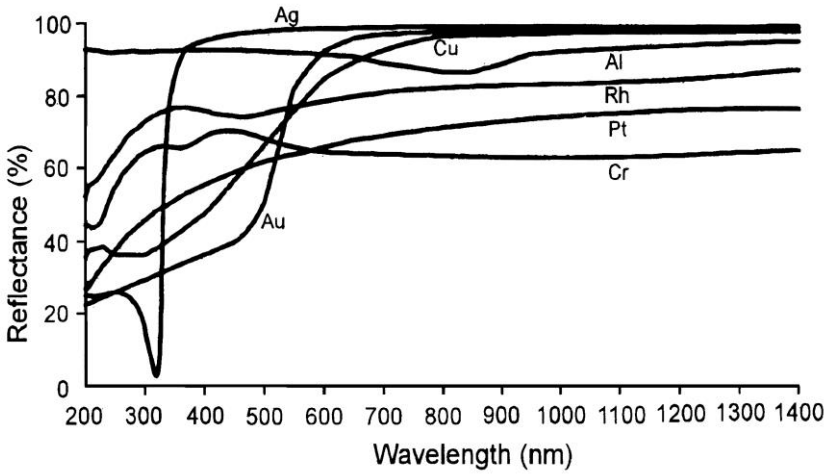


光是來自很多不同角度進入ODR

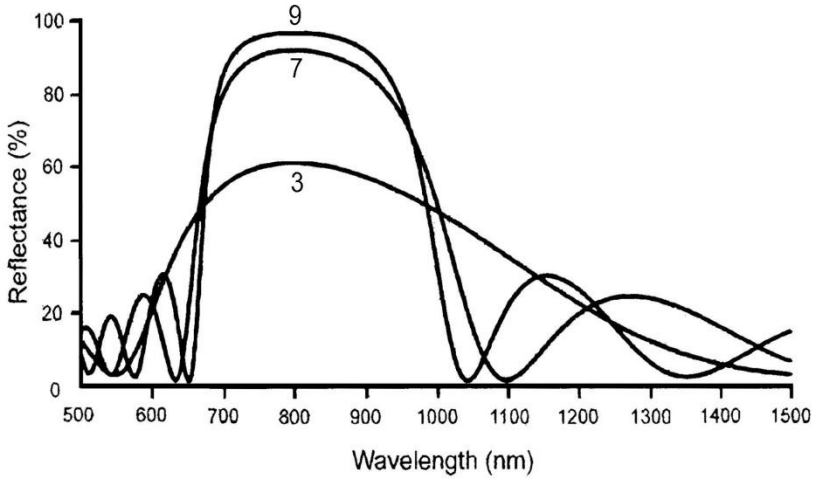


High Reflectance Mirror

對於特定波長具有相當高之反射率



金屬膜



介質膜

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Compare with Metal and DBR

材料	反射率	備註
Al	85%-90%	
Ag	92%-95%	硫化會變黑
DBR	98%以上	TiO2/SiO2 約29層，導熱性差
ODR(DBR+Al)	95%以上	最少7層以上，導熱性附著性好

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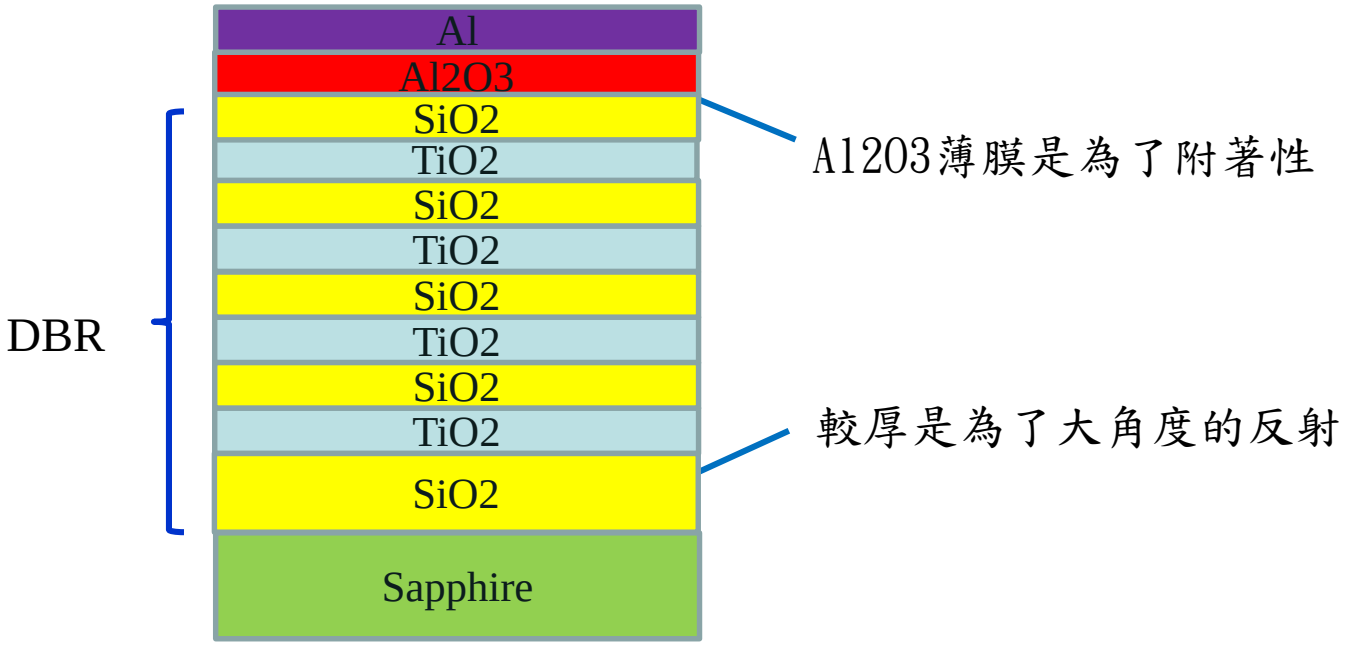
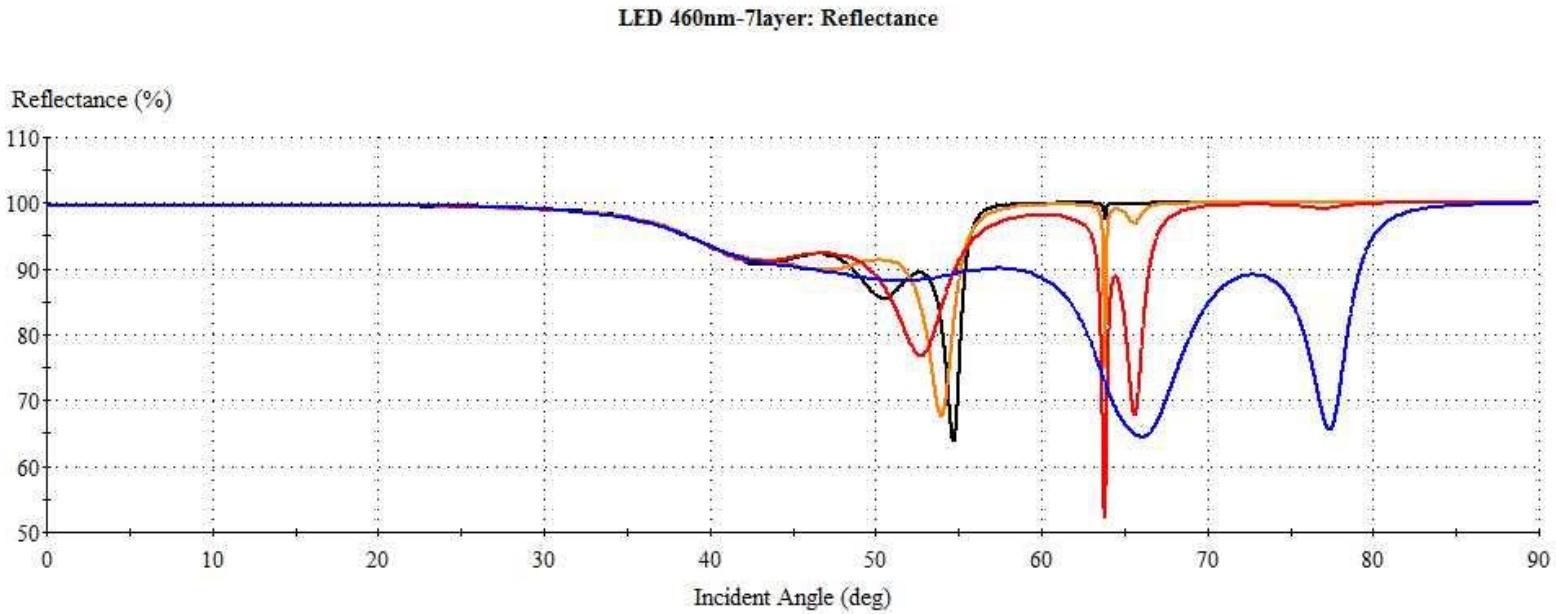
Structure of ODR(DBR+Al)



First layer (SiO2) effect



黑線(560nm)，橘線(400nm)，紅線(240nm)，藍線(80nm)

厚度越厚，60-90度反射率越高(不影響0-40度)

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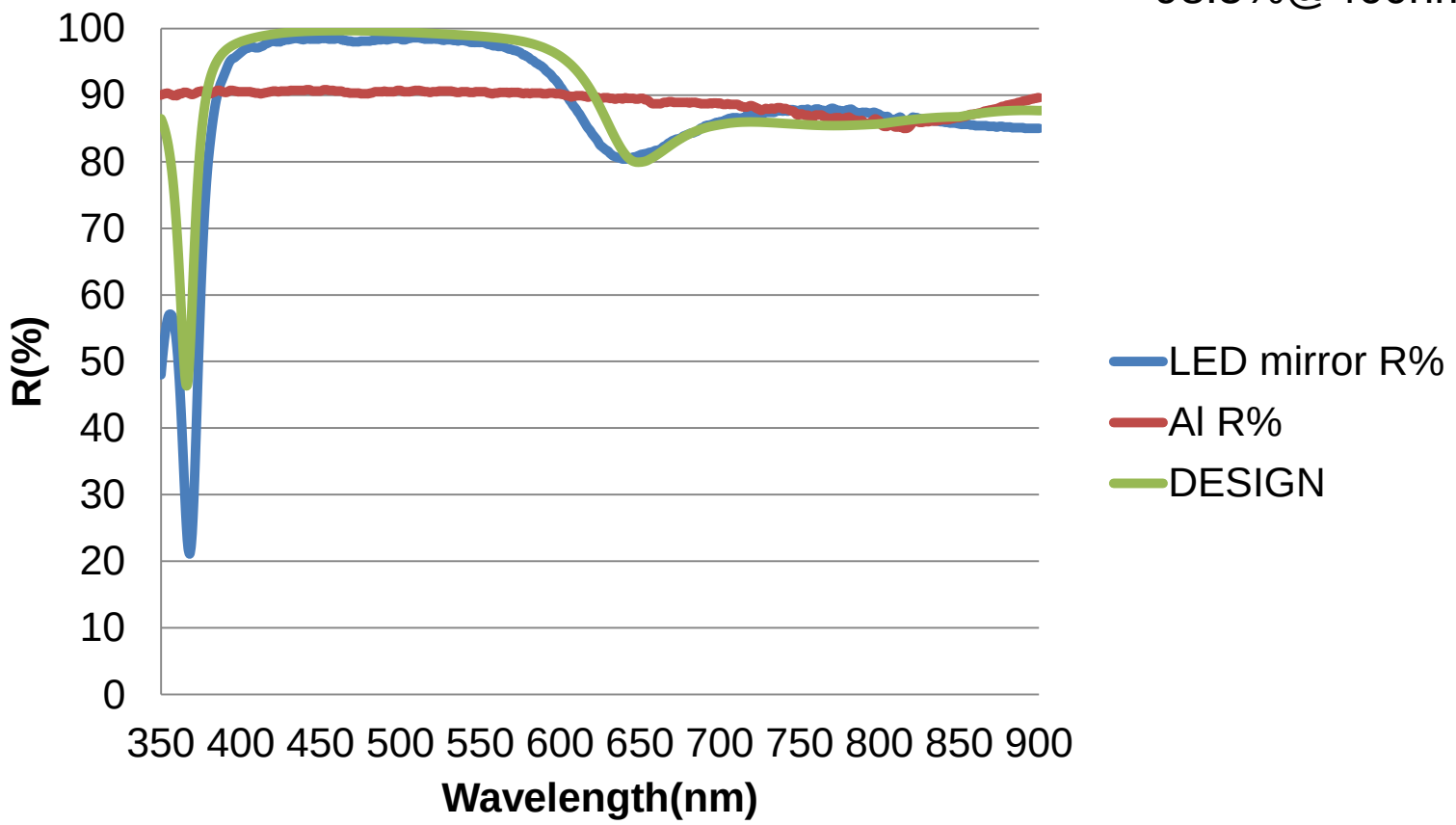
Sample Design(7layer)

Layer	Material	Optical Thickness (QWOT)	Physical Thickness (nm)
Medium	Spphire		
1	SiO2	7	547.77
2	TiO2	1	43.69
3	SiO2	1	78.25
4	TiO2	1	43.69
5	SiO2	1	78.25
6	TiO2	1	43.69
7	SiO2	1	78.25
8	Al2O3	0.072878	5
Substrate	Al		

Sample Spectrum(7layer)

98.5%@460nm



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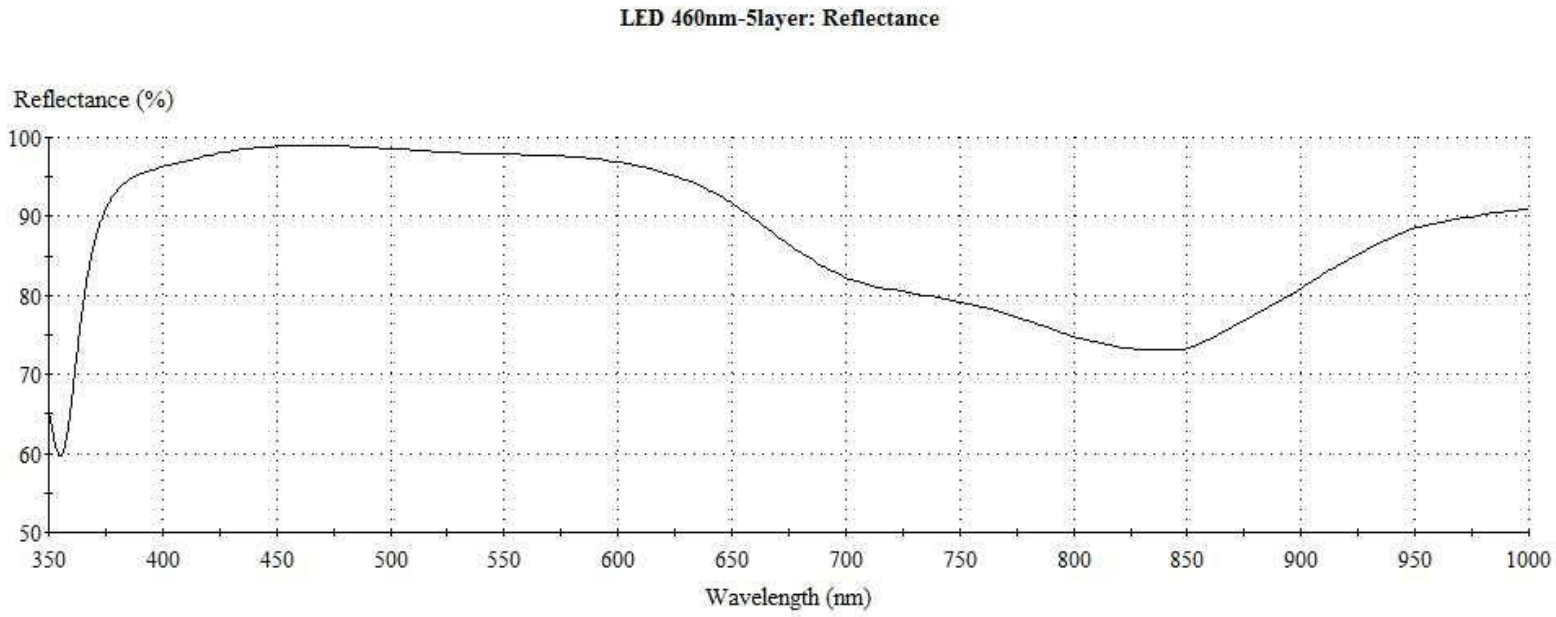
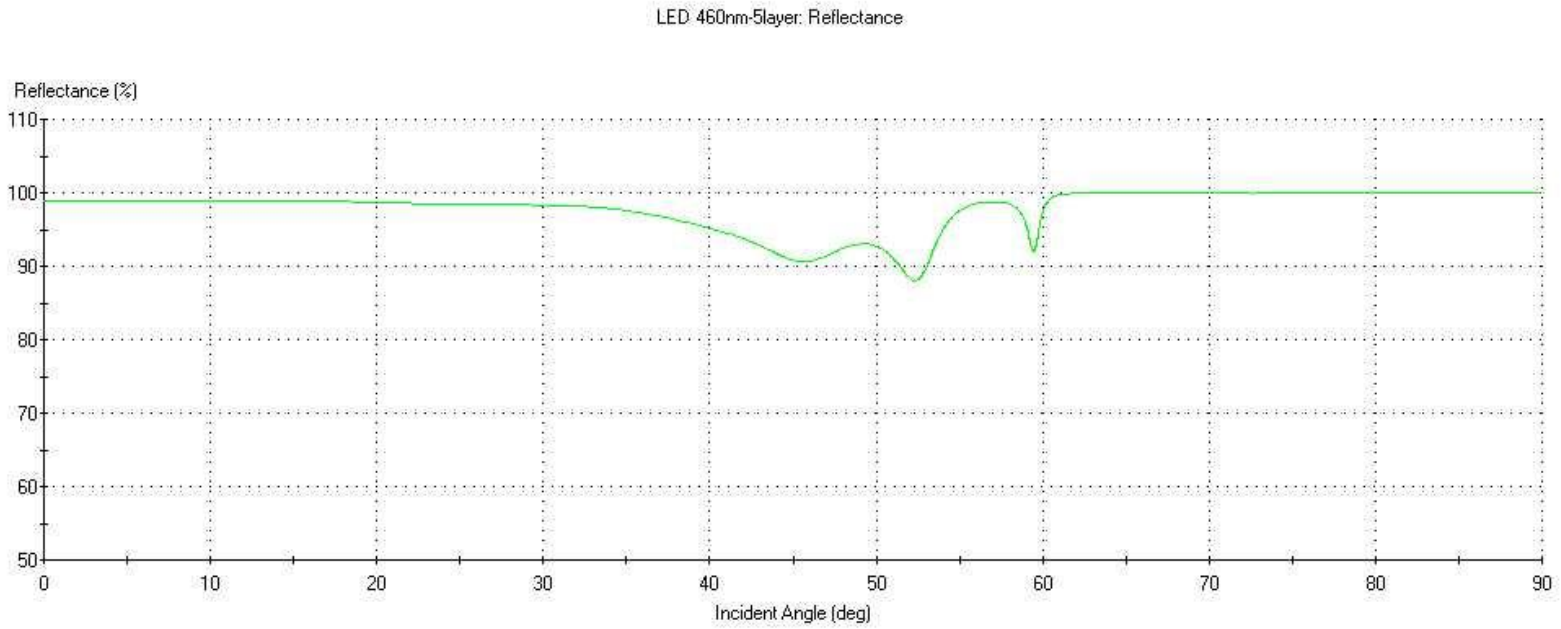
Compare different layer design

DBR layer number	Total thickness
5	0.80um
7	0.92um
8(優化)	1.15um
29(優化)	2.82um

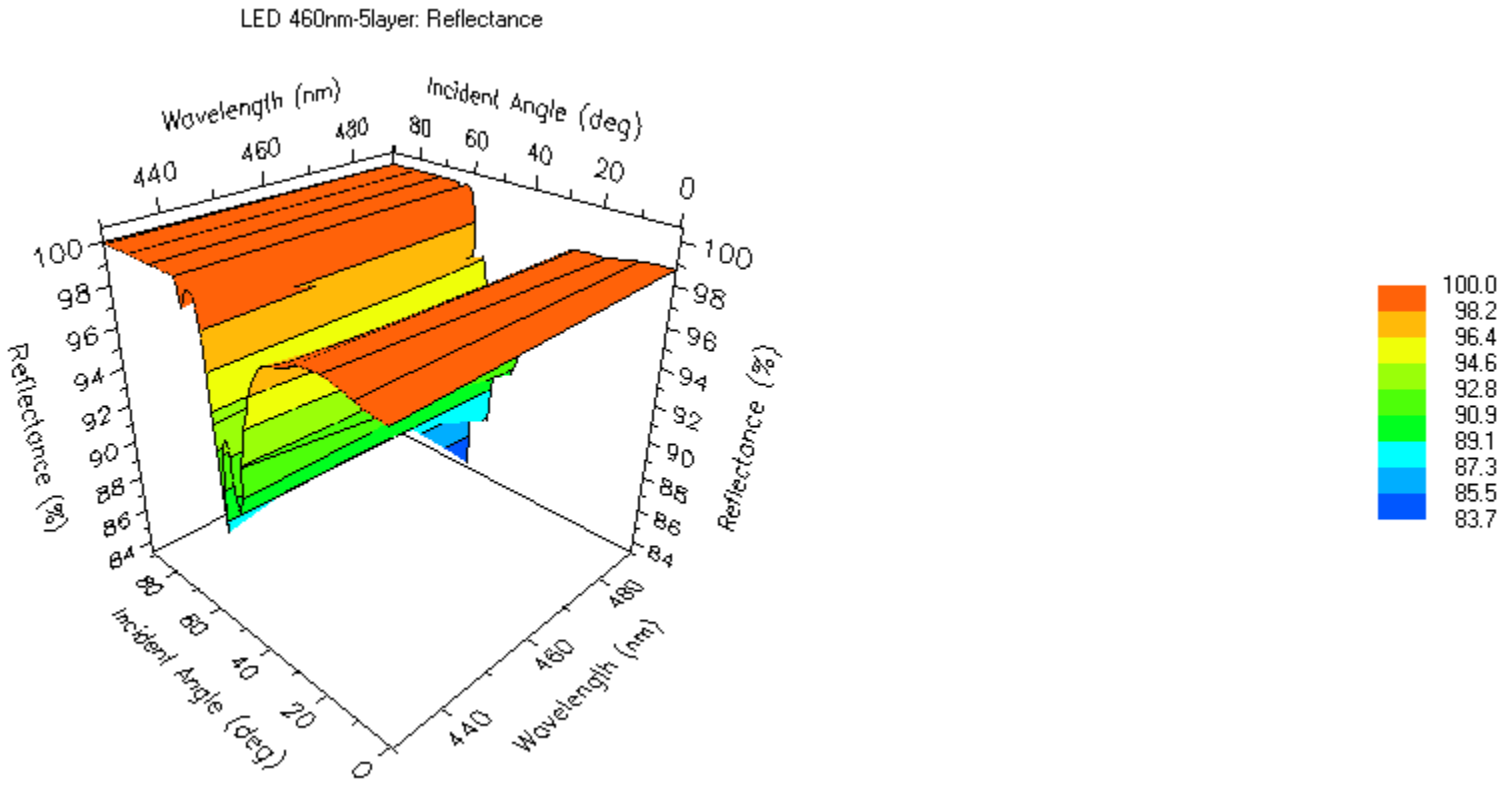
DBR 5layer R% VS Wavelength



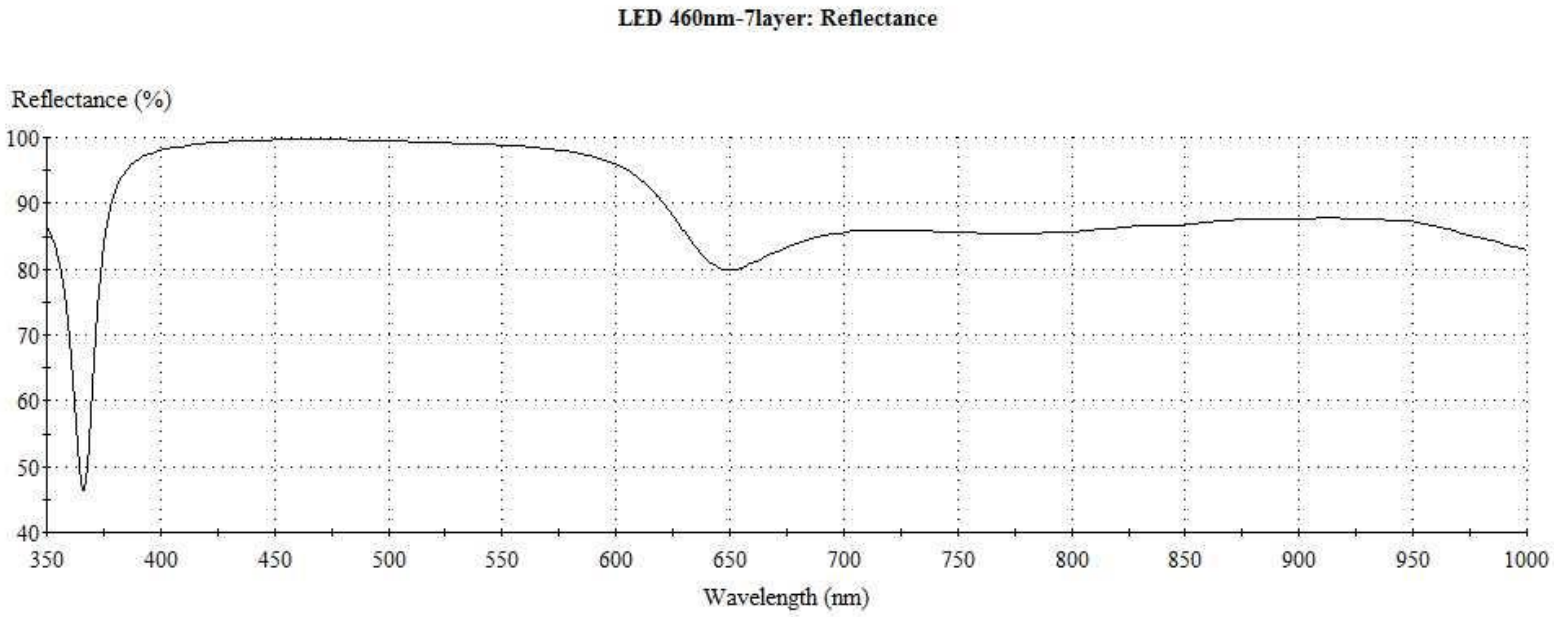
DBR 5layer R% VS Angle (460nm)



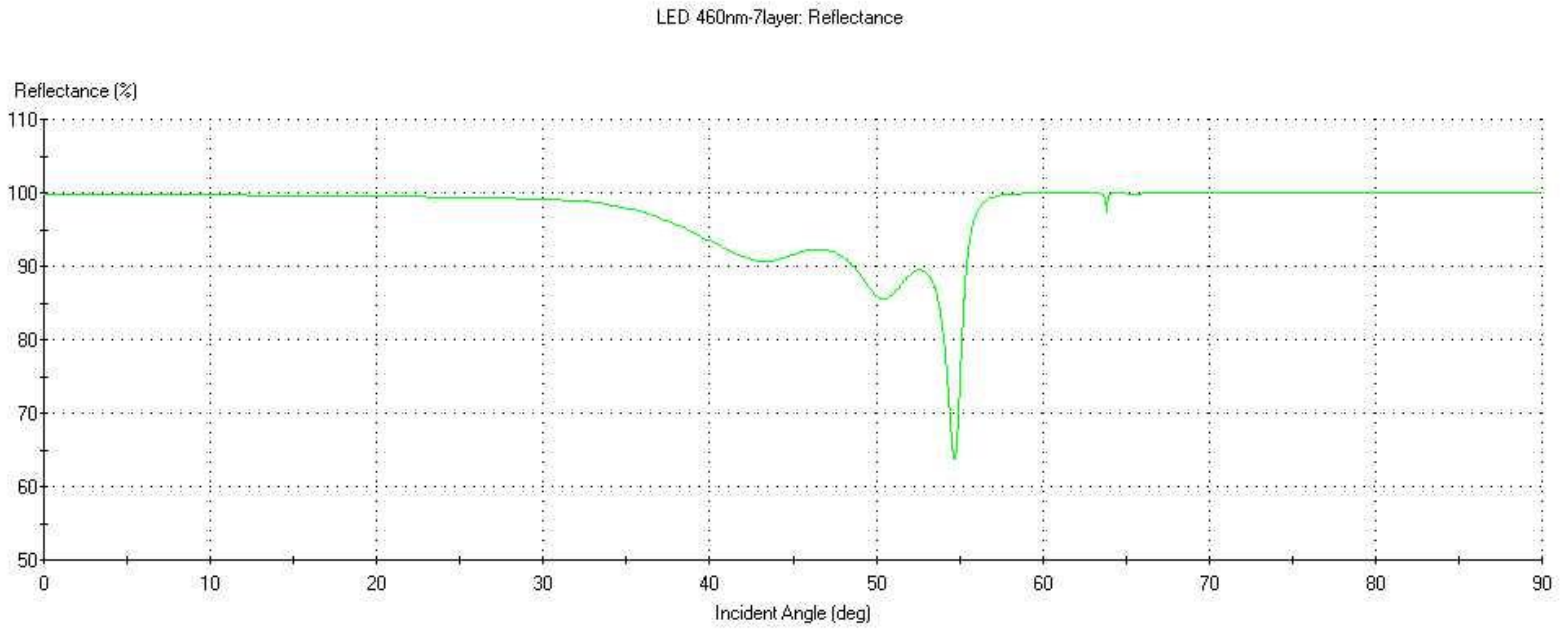
DBR 5layer R% VS Angle VS Wavelength



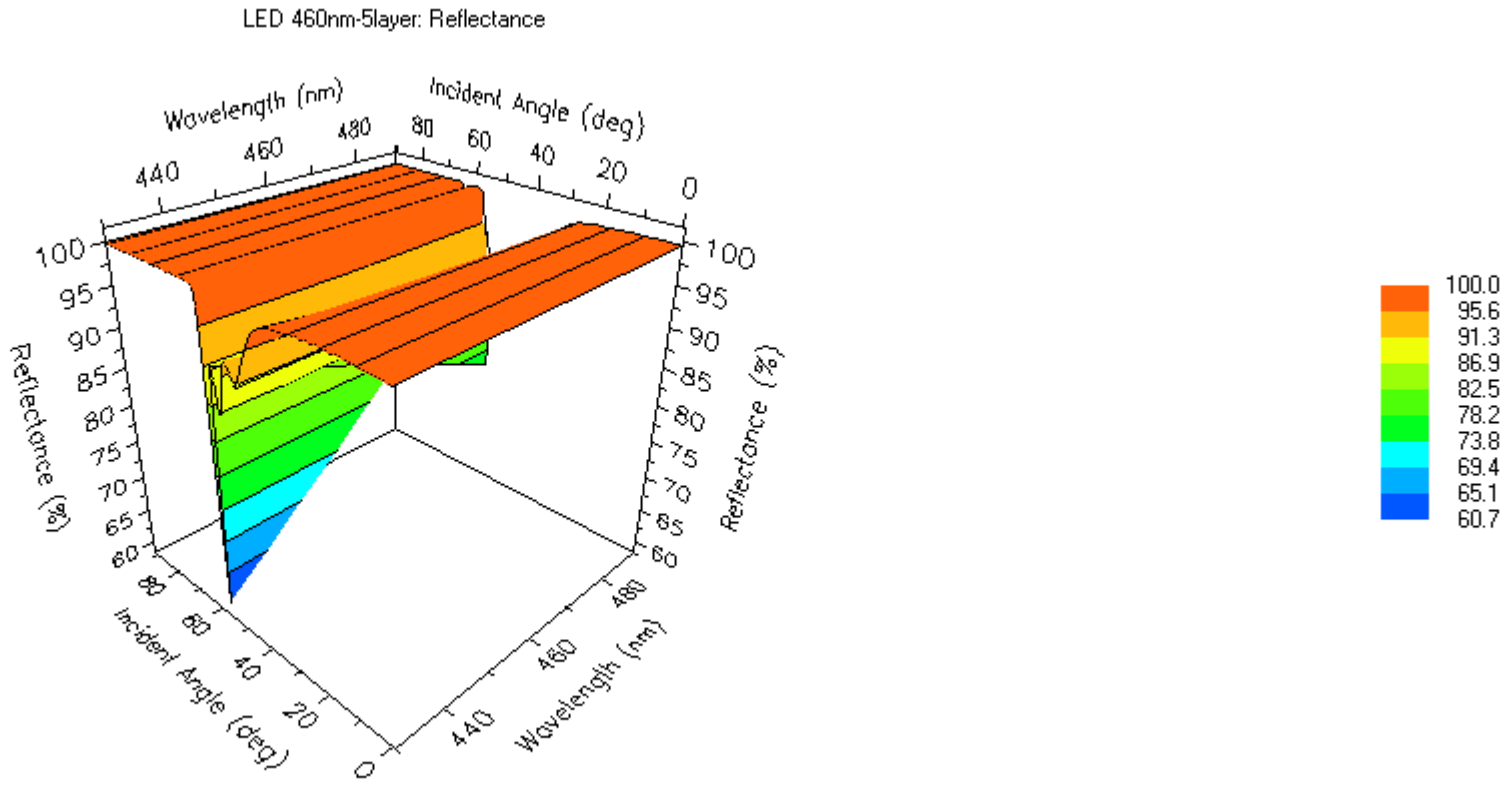
DBR 7layer R% VS Wavelength



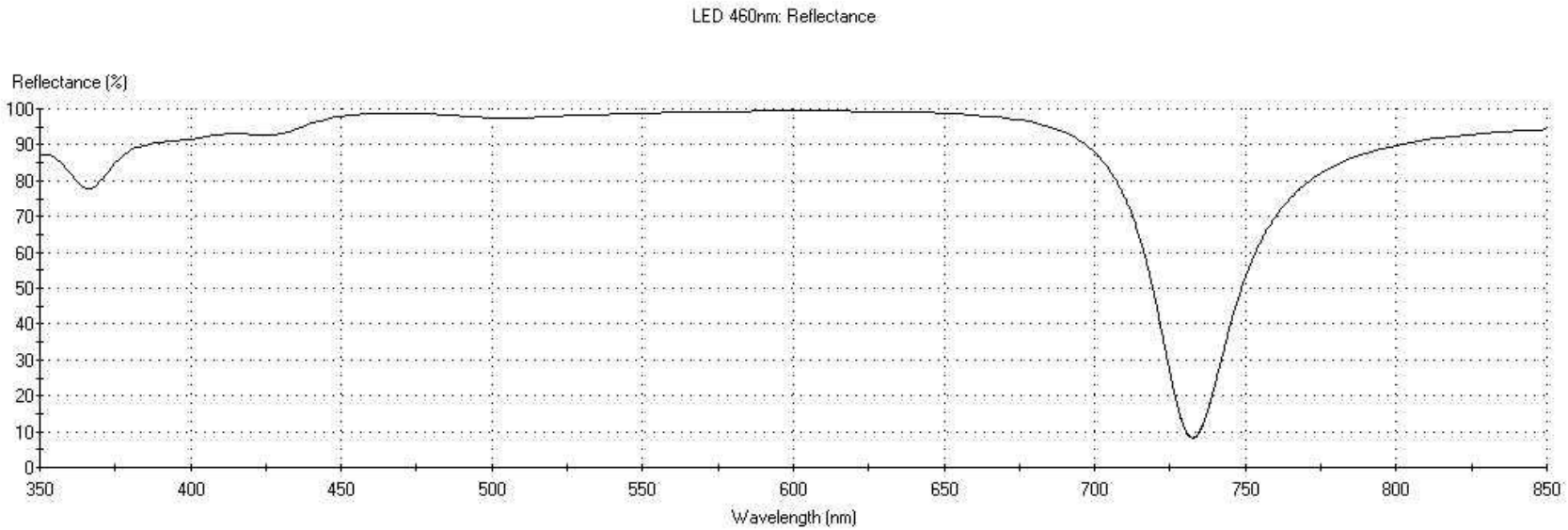
DBR 7layer R% VS Angle (460nm)



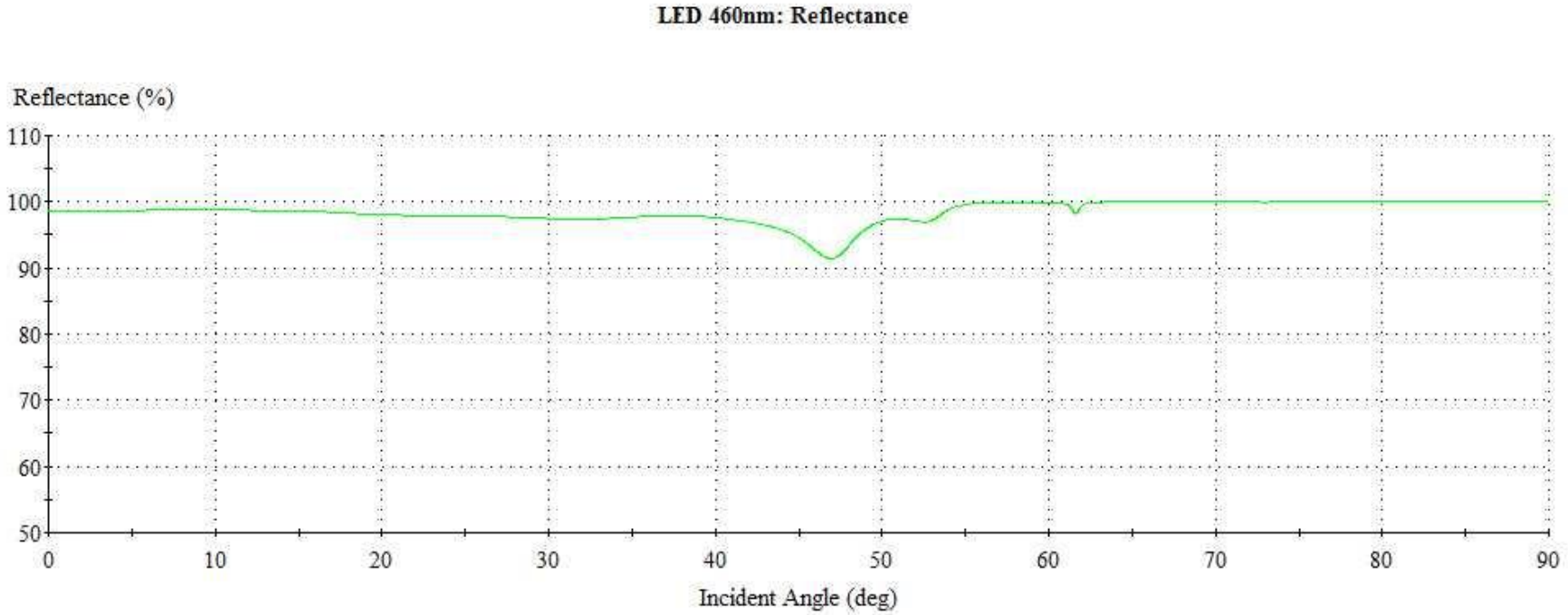
DBR 7layer R% VS Angle VS Wavelength



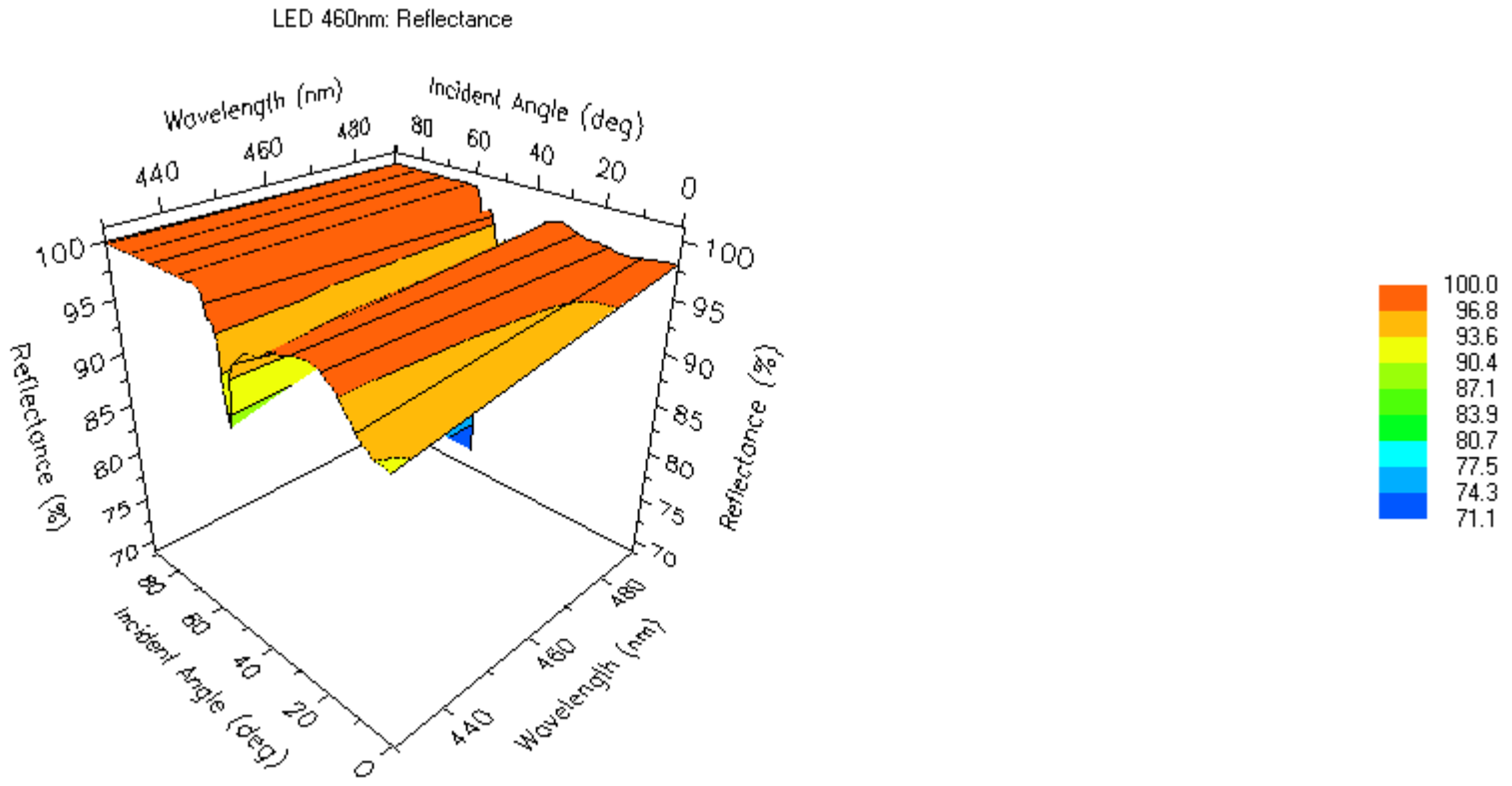
DBR 8layer R% VS Wavelength(優化)



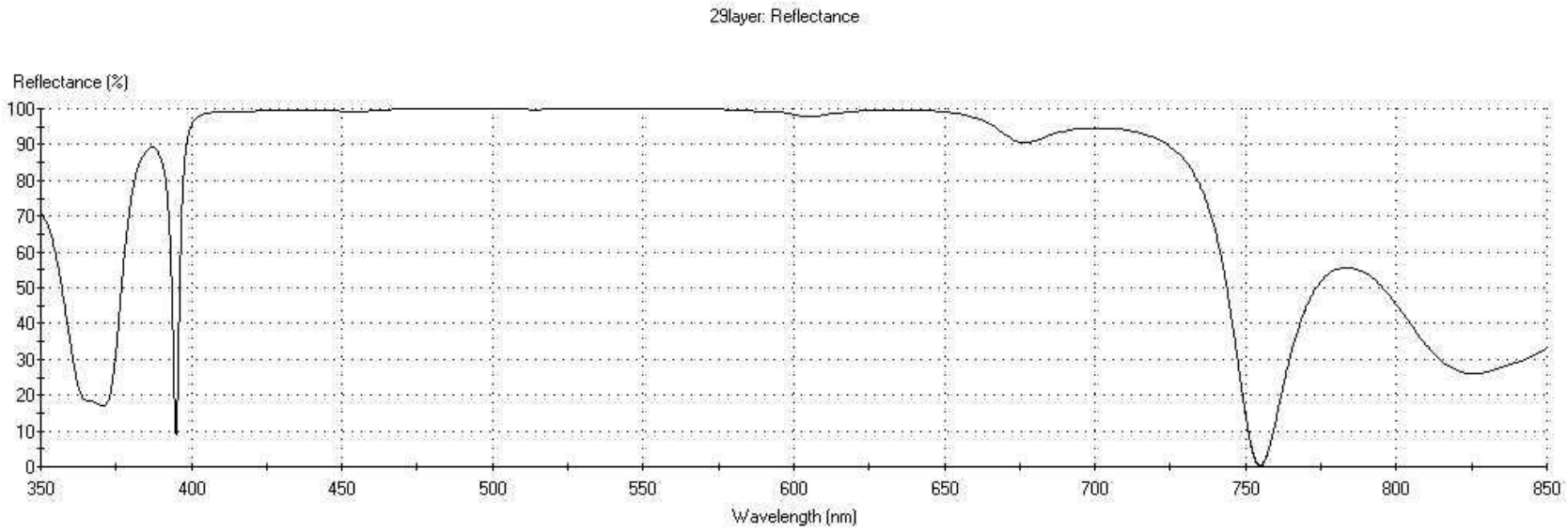
DBR 8layer R% VS Angle (460nm) (優化)



DBR 8layer R% VS Angle VS Wavelength (優化)

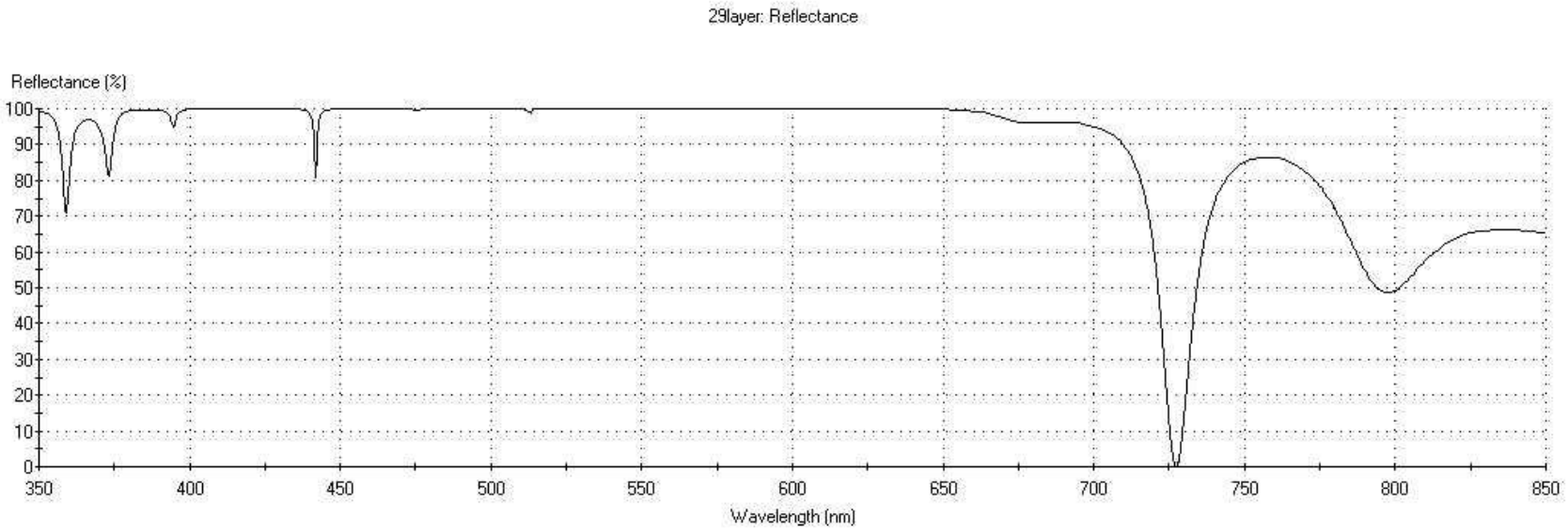


DBR 29layer R% VS Wavelength(優化)



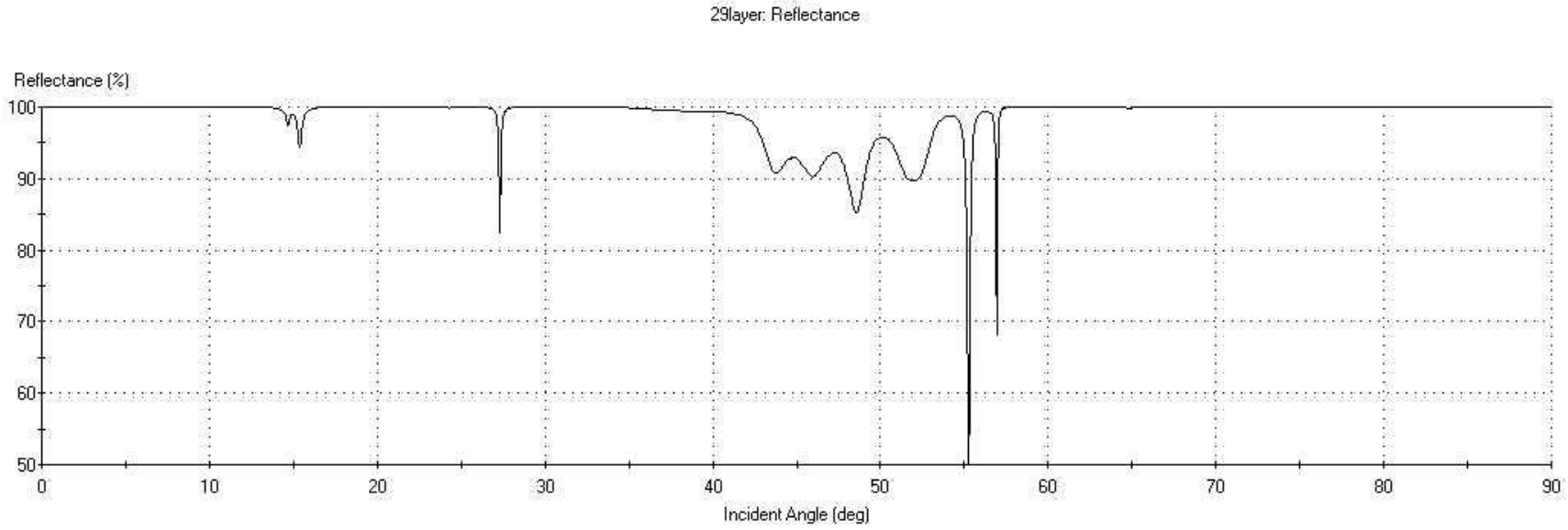
(without Al)

DBR 29layer R% VS Wavelength(優化)

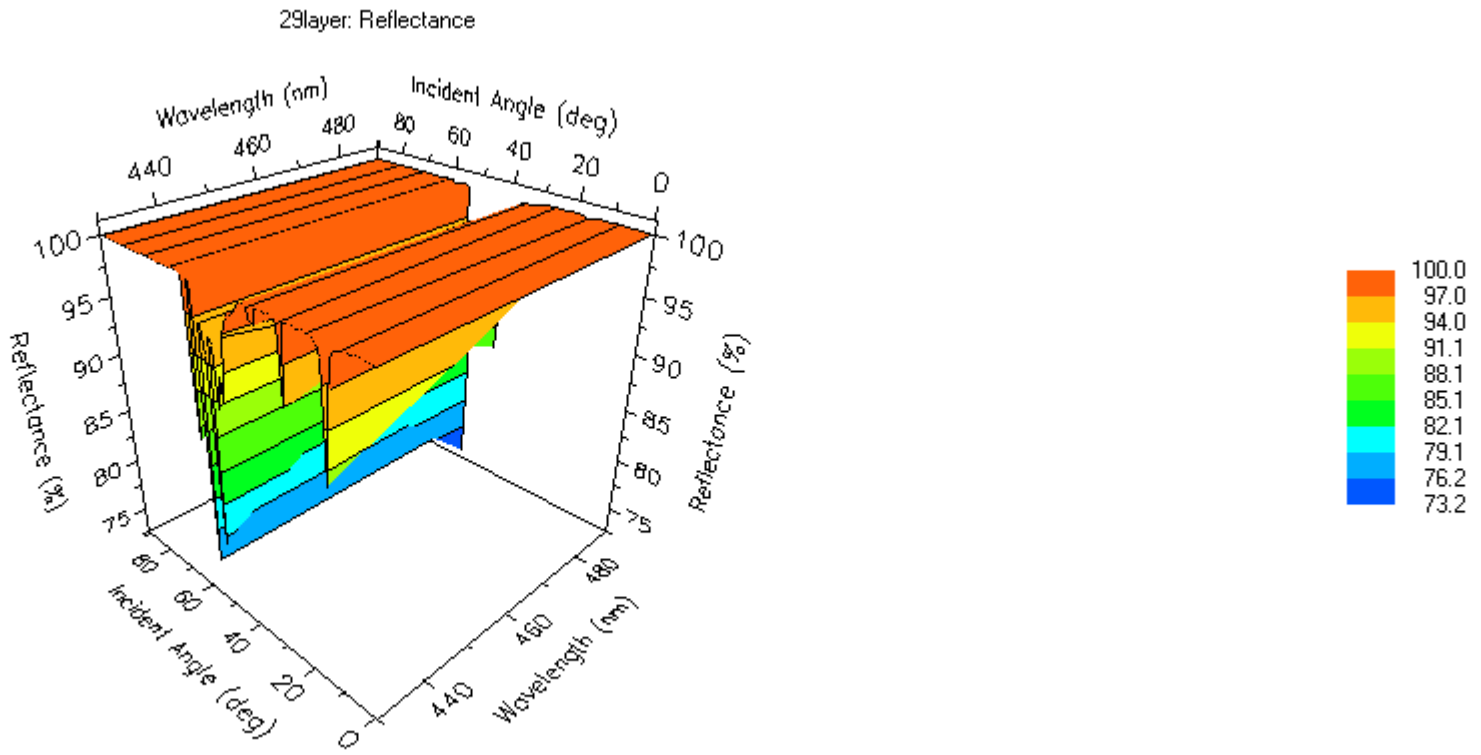


(with Al)

DBR 29layer R% VS Angle (460nm) (優化)

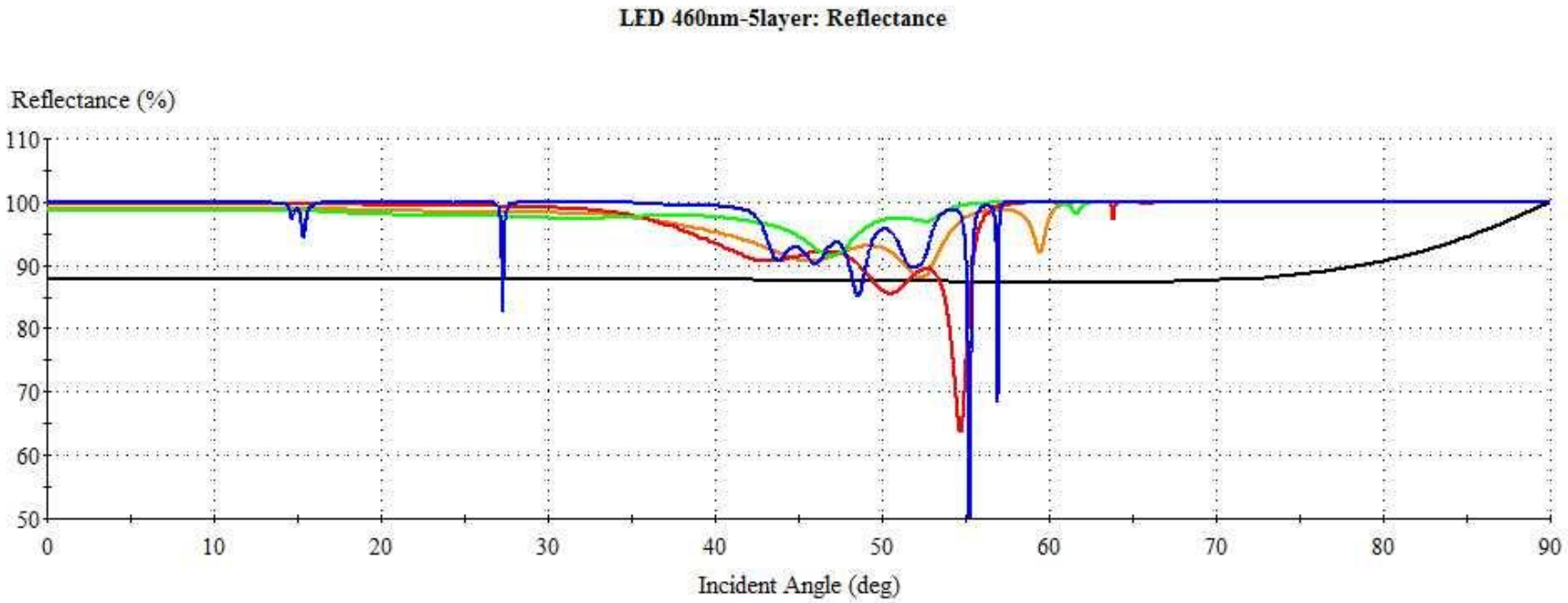


DBR 29layer R% VS Angle VS Wavelength (優化)

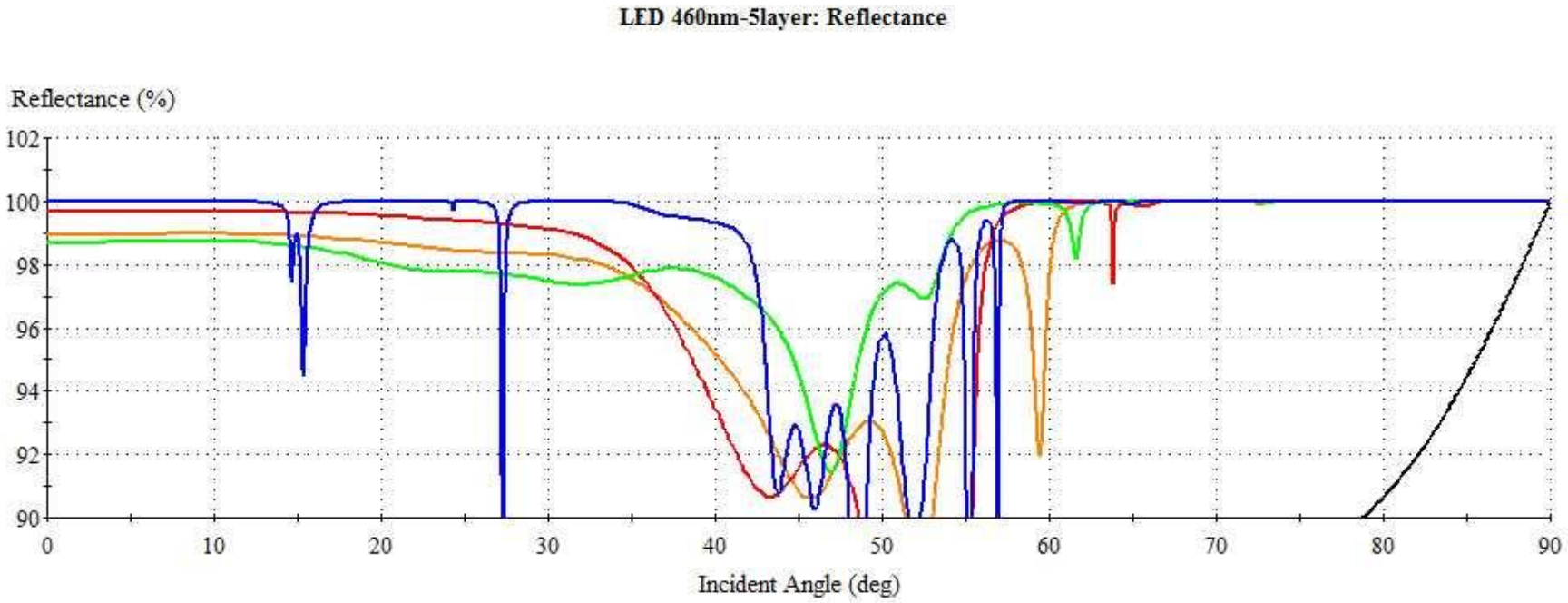


Compare of Different Design

不同角度之反射率@460nm



黑線為鋁膜,**橘線**為加了5層介電質膜，**紅線**為加了7層介電質膜，**綠線**為加了8層介電質膜，**藍線**為加了29層介電質膜提高反射率

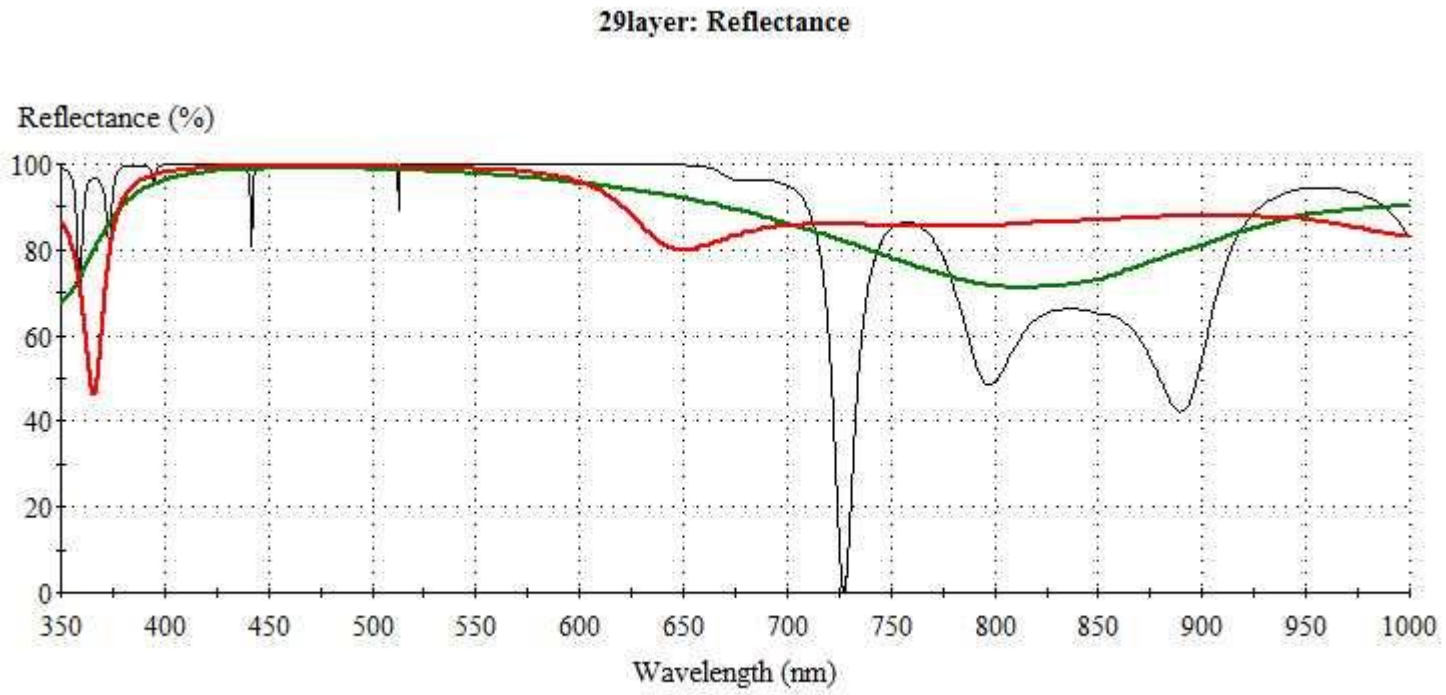


黑線為鋁膜,**橘線**為加了5層介電質膜，**紅線**為加了7層介電質膜，**綠線**為加了8層介電質膜，**藍線**為加了29層介電質膜提高反射率

- 橘紅藍線表示，隨著層數增加，反射率就會增加
- 綠線表示，經優化後，整體比較好，但是在460nm反射率較低
- 層數越多，40~60度會有較大的損耗

0~90 degree Reflectance (average)@460nm
8層介電質膜(優化) 98.5%
29層介電質膜 (優化) 98.8%

Compare of Different Design



光譜波寬:黑線29層介電質膜>**綠線**5層介電質膜>**紅線**7層介電質膜

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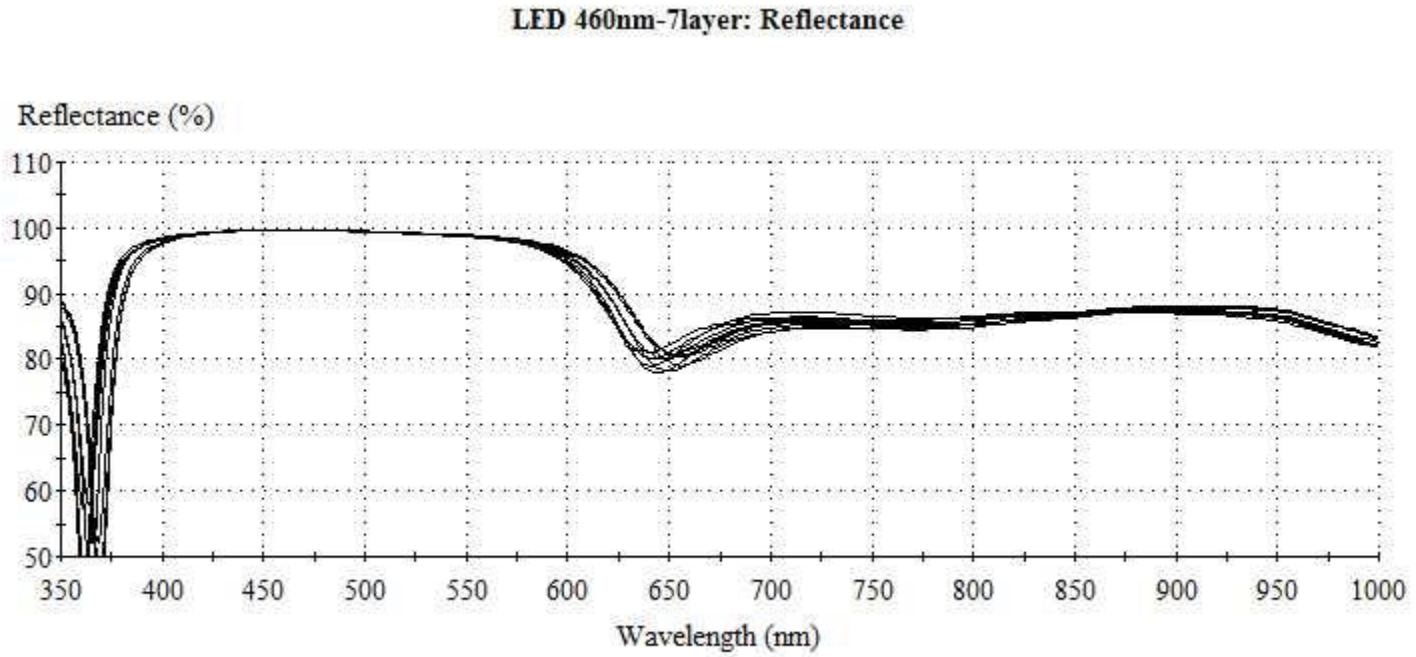
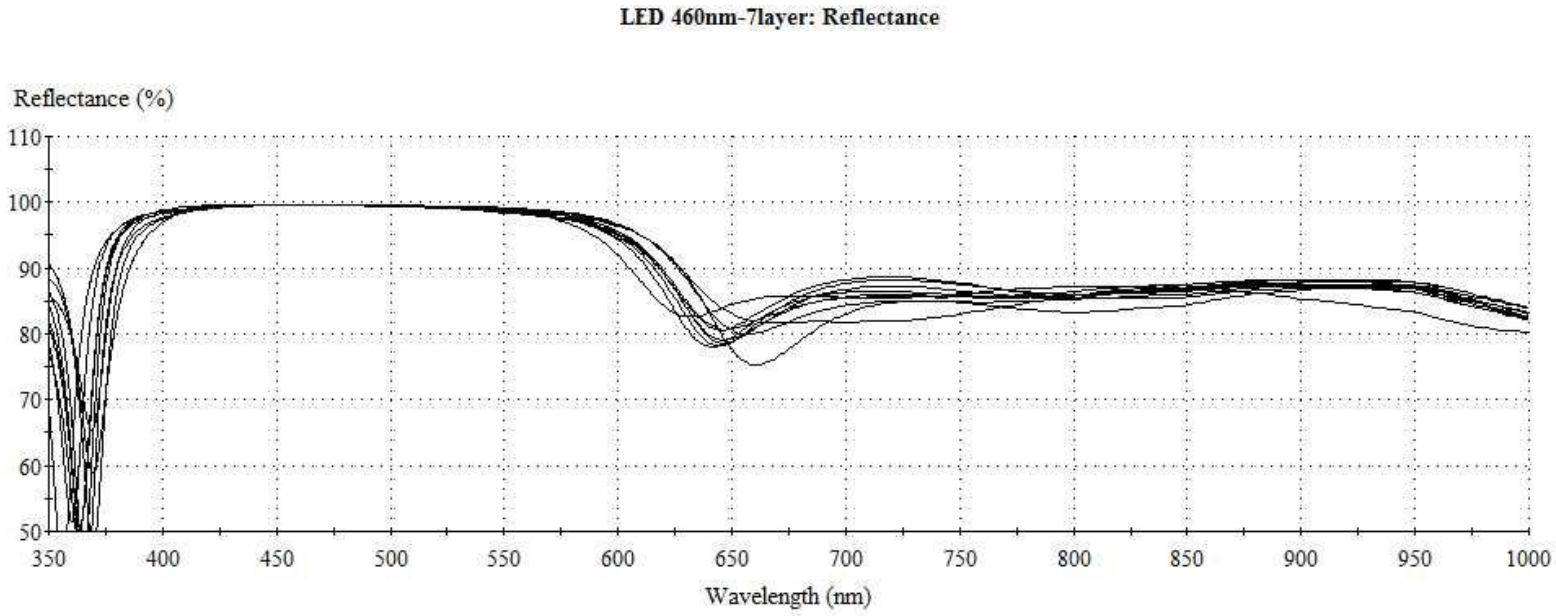
Thickness error 2% result



Thickness error 3% result



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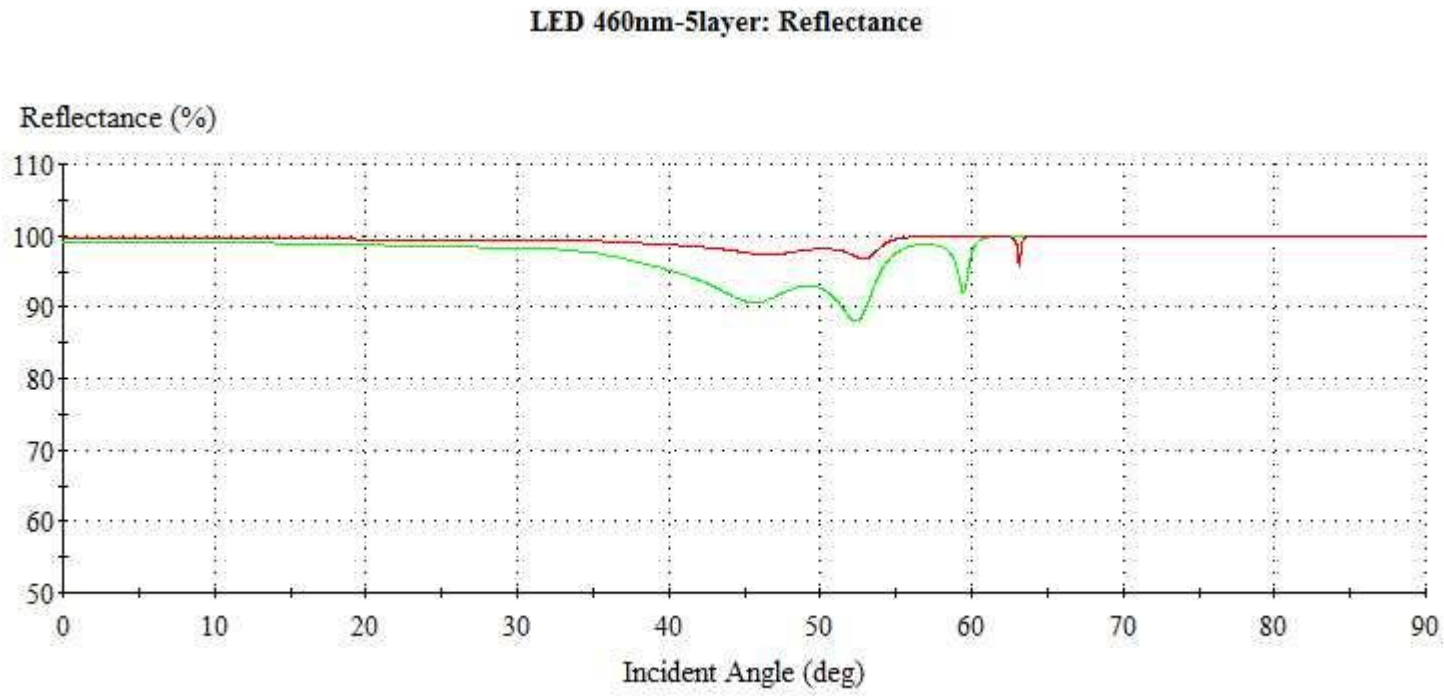
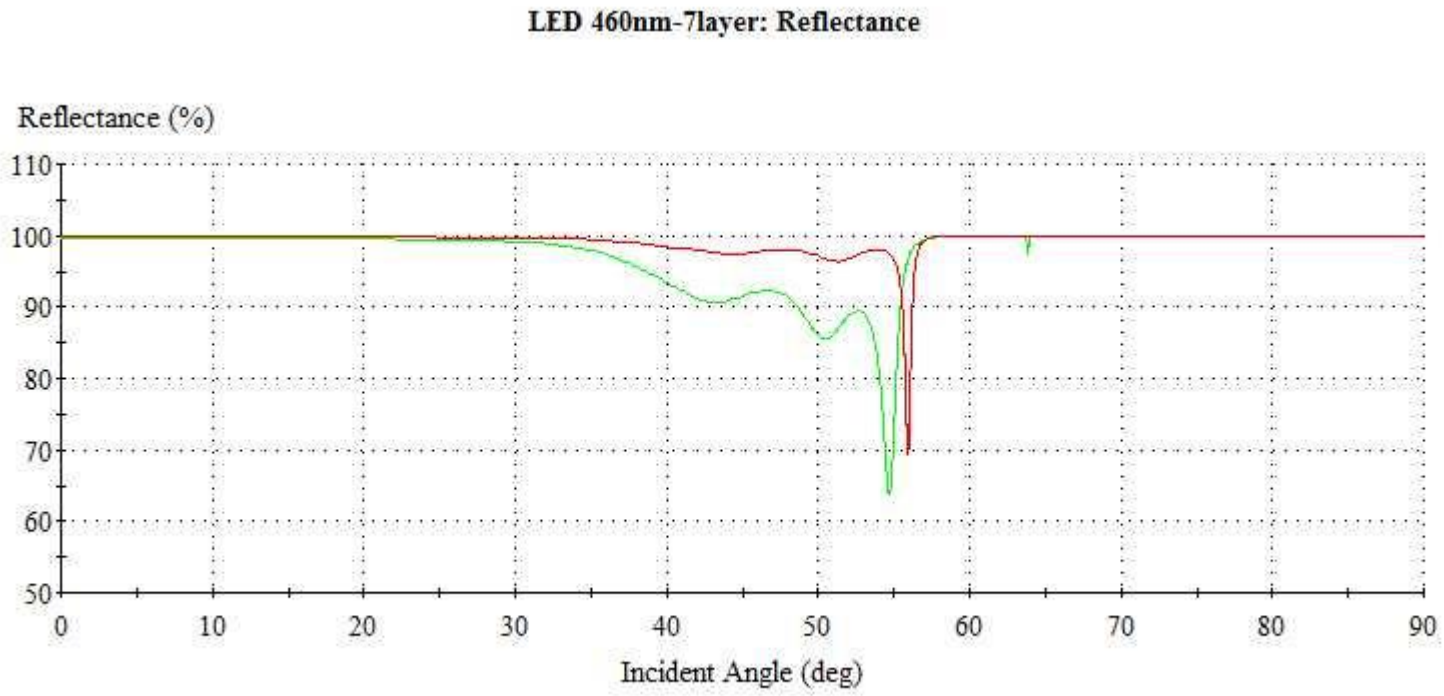
DBR(5layer) with Al/Ag



綠線Al/紅線Ag

Ag明顯的比Al好

DBR(7layer) with Al/Ag



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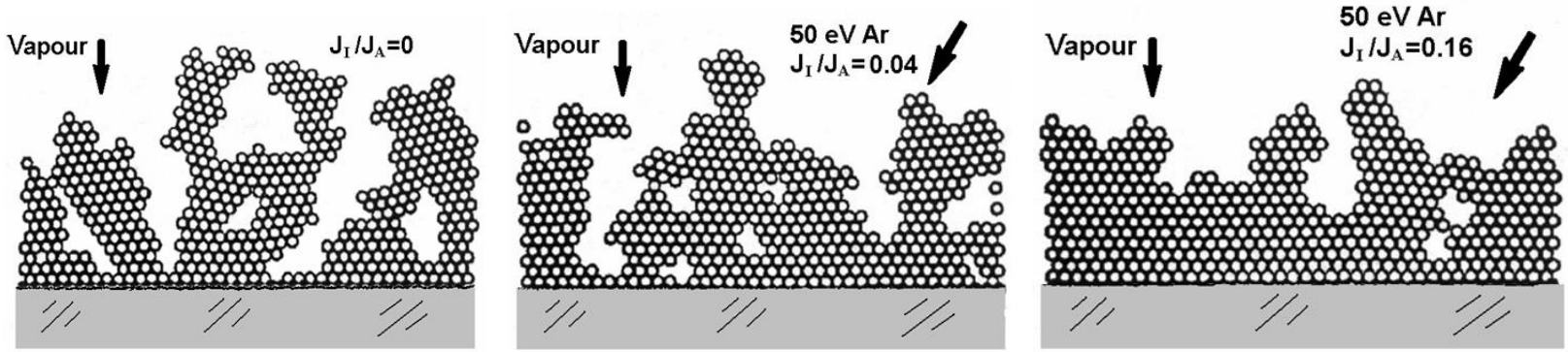
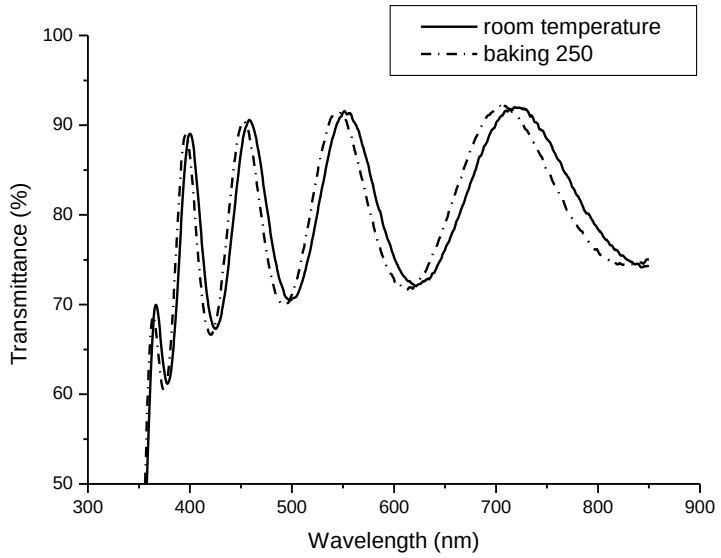
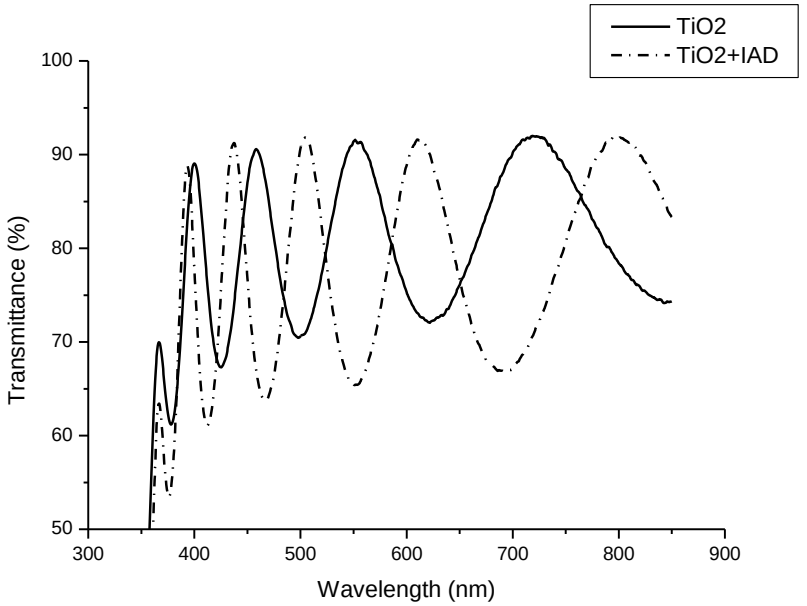
Simulation of ion source bombard



Advantage of ion source bombard

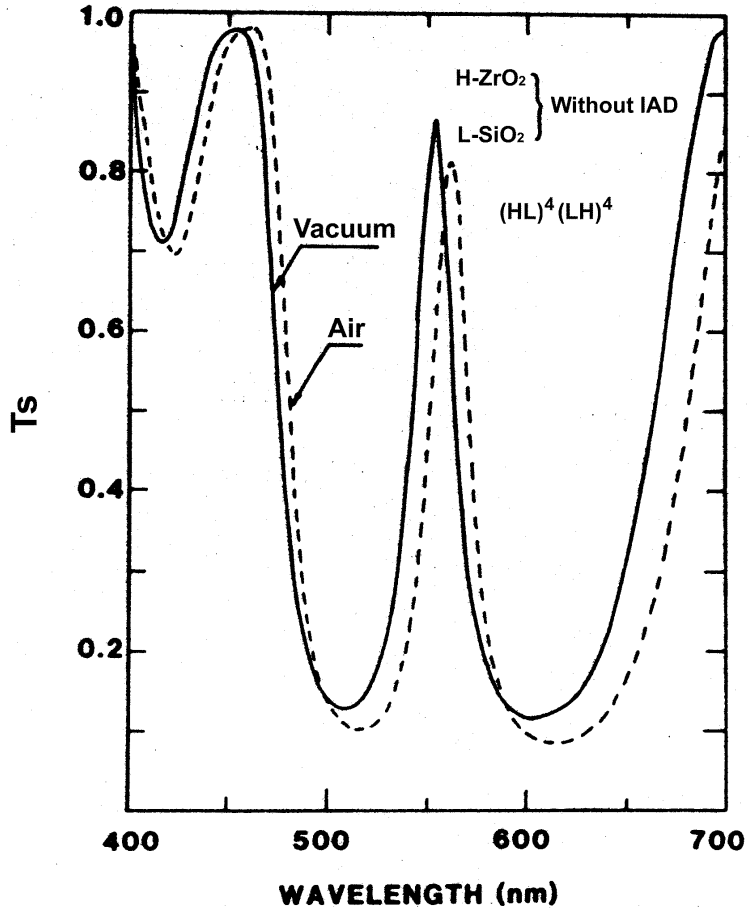


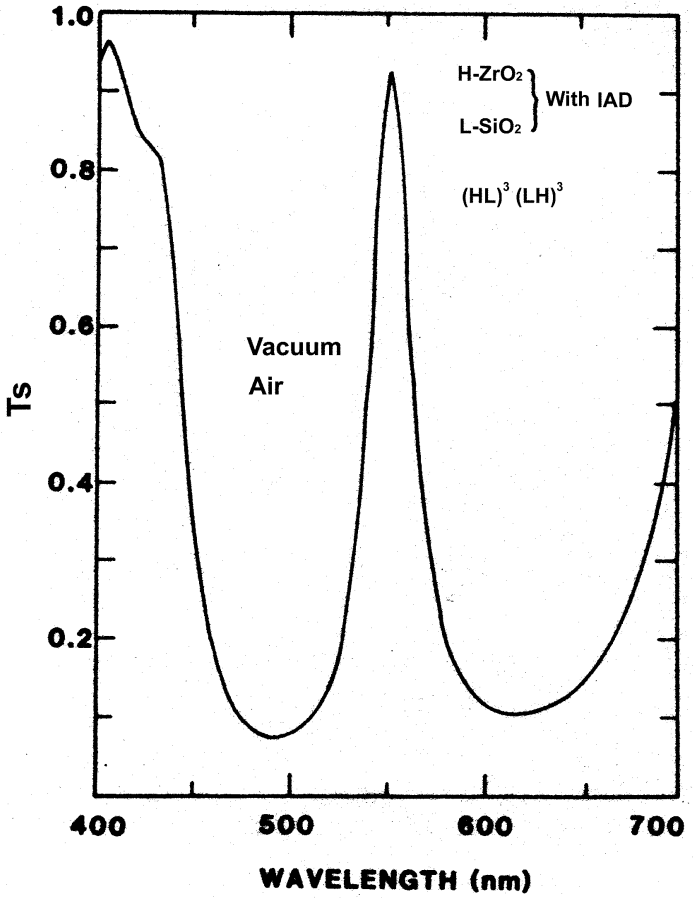
無離子助鍍TiO2膜加熱後的光譜飄移圖



有無離子助鍍之TiO2光譜圖

Advantage of ion source bombard





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Conclusion

- ODR必須考慮每個角度入射造成的影響；
- DBR 8 layers 優化可達到29 layers的效果；
- 第一層SiO2變厚，有效提升60-90度的反射；
- 在10層設計之下，使用石英震盪器時厚度誤差3%之內，不需要使用光學監控；
- 離子源助鍍有效提高折射率以及環境穩定性。