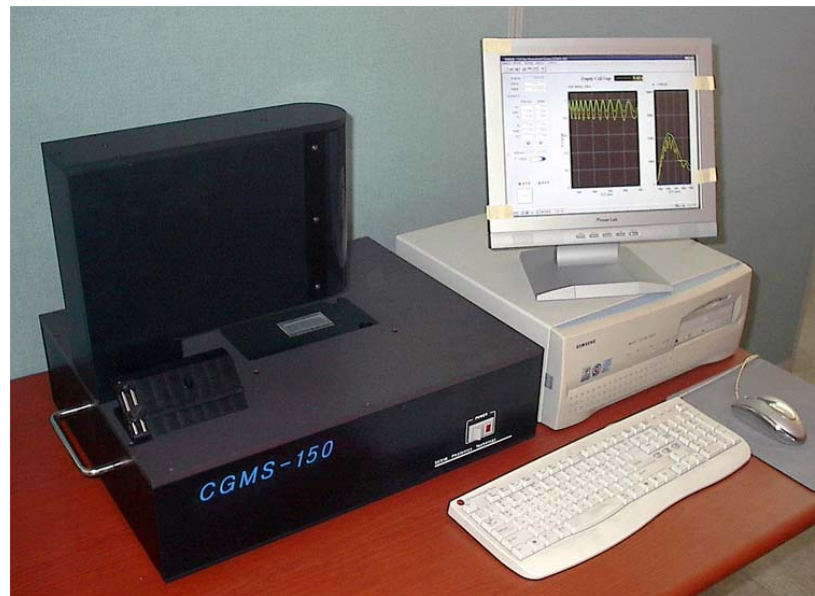


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*Empty & Filled Cell-Gap Measurement System*

# CGMS-150



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**Sesim**

*Sesim Photonics Technology Co. Ltd.*  
<http://www.sesimlcd.co.kr>

# Introduction

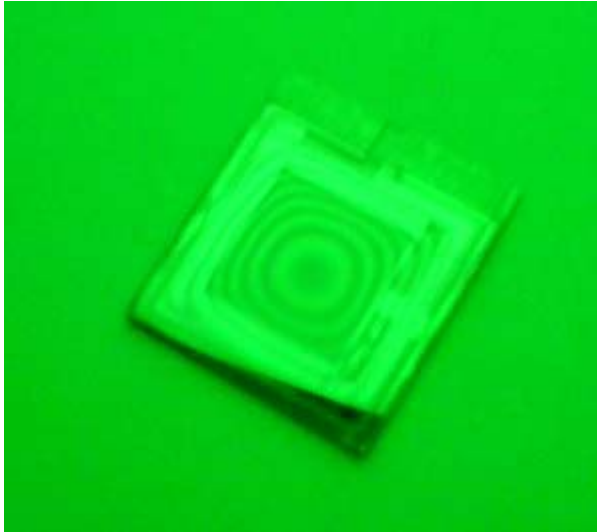
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세심광전자기술(주)의 CGMS-150는 LCD Empty/Filled Cell의 Cell-Gap을 측정하는 장비이다.

- **Empty & Filled Cell의 Cell-Gap 측정**
- **투과형**
- **Filled Cell-Gap 측정 가능 LC mode : TN, STN, ECB, IPS, VA**
- **Basic specification**
  - \* 측정 정밀도 : Empty Cell => 0.02 um  
Filled Cell =>  $\Delta nd < 0.003$  um
  - \* 측정 파장 범위 : 450 nm ~ 800 nm
  - \* Beam size : under 2 mm
  - \* Sample size : General => Diagonal size 17"  
VA mode => 40 mm X 40 mm Rectangular
  - \* 실험Table에 설치할 수 있는 Compact Type
  - \* Manual 측정

# Measurement principle : Newton ring

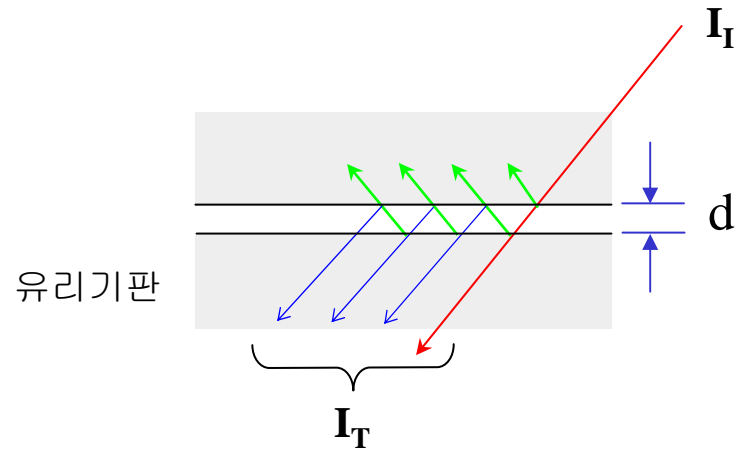
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- 파장 일정
- Cell-Gap이 변하는 경우 : Ring 생성
- Ring사이의 Cell-Gap 변화량 : 파장/2

# Measurement principle : Empty Cell-Gap (1/5)

- 단층박막의 Cell-Gap 측정 원리 : 다중반사



$$\mathbf{I_T/I_I} = \frac{1}{1 + F \cdot \sin^2(\Delta/2)} \quad (\Delta/2 = m\pi : \text{보강간섭, } m=\text{정수})$$

$$\Delta = 2\pi(2 \cdot d)/\lambda$$

d : Cell-Gap

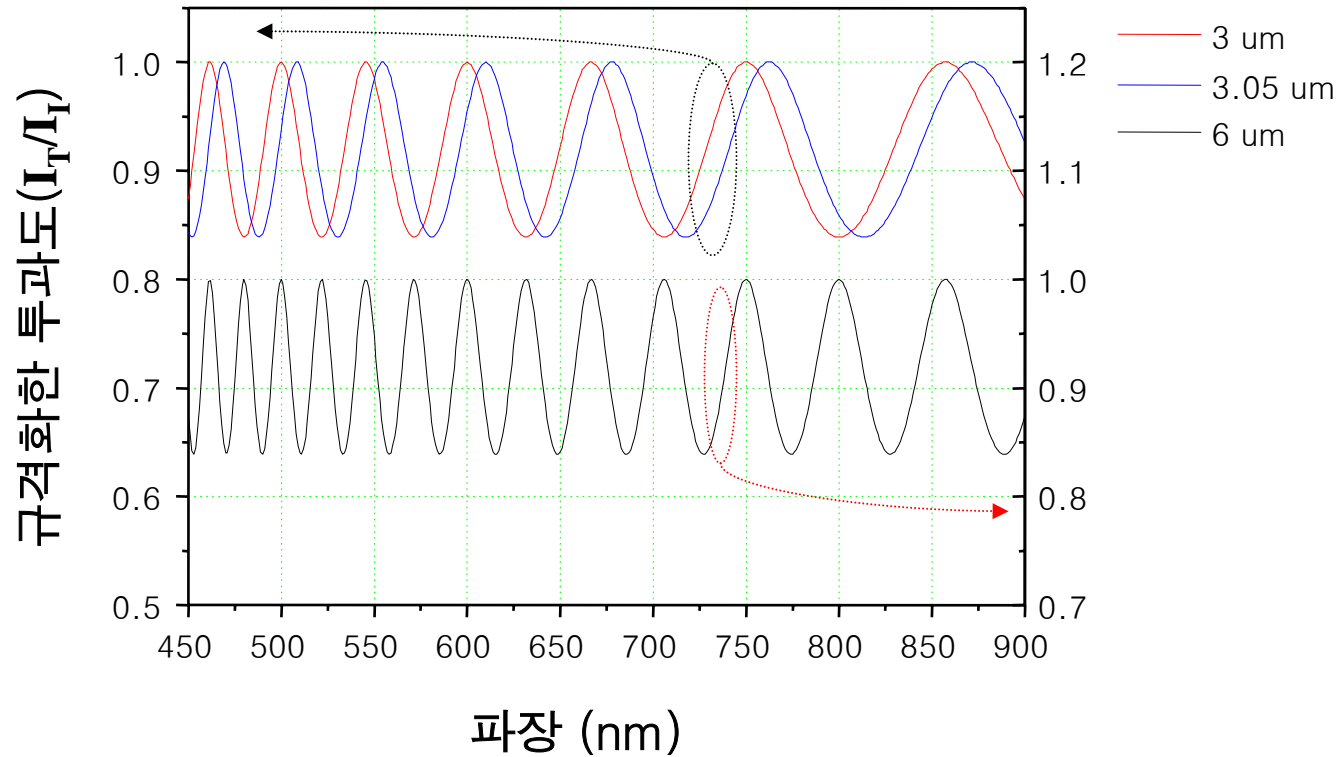
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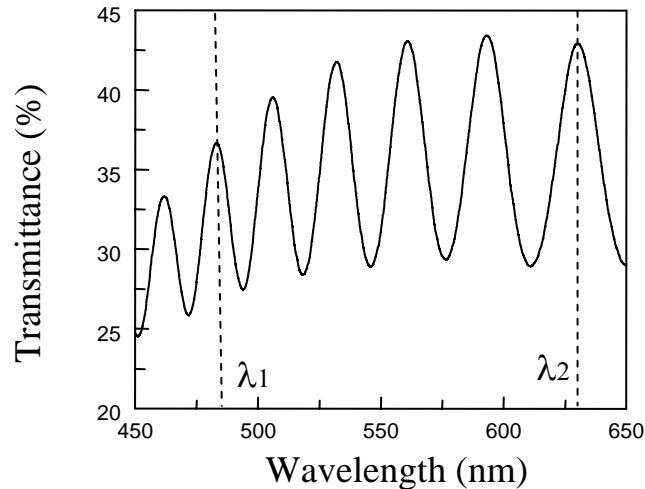
# Measurement principle : Empty Cell-Gap (2/5)

- 단층박막의 투과 특성



# Measurement principle : Empty Cell-Gap (3/5)

- 단층박막의 Cell-Gap 결정



( Calculation Example )

$$\lambda_1 = 462 \text{ nm}$$

$$\lambda_2 = 631 \text{ nm}$$

$$\kappa = 5$$

$$d = 4.31 \mu\text{m}$$

$$\Delta(\lambda_1)/2 = 2\pi d/\lambda_1$$

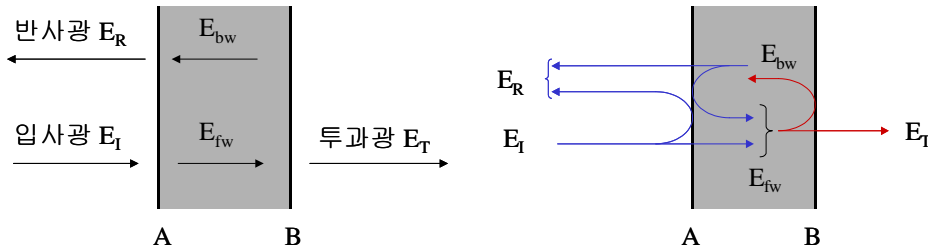
$$\Delta(\lambda_2)/2 = 2\pi d/\lambda_2 = 2\pi d/\lambda_1 - \kappa\pi$$

$\kappa$  : 파장  $\lambda_1$ 과  $\lambda_2$  사이의 Peak 수

$$d = \frac{\kappa}{2(1/\lambda_1 - 1/\lambda_2)}$$

# Measurement principle : Empty Cell-Gap (4/5)

• 다중박막의 Cell-Gap Simulation



입사광, 반사광, 투과광의 경계조건

$$\begin{pmatrix} 1 & -r \\ 0 & t \end{pmatrix} \begin{pmatrix} E_R \\ E_I \end{pmatrix} = \begin{pmatrix} t' & 0 \\ -r' & 1 \end{pmatrix} \begin{pmatrix} E_{bw} \\ E_{fw} \end{pmatrix}$$

$$\begin{pmatrix} E_R \\ E_I \end{pmatrix} = \frac{1}{t} \begin{pmatrix} 1 & r \\ r & 1 \end{pmatrix} \begin{pmatrix} E_{bw} \\ E_{fw} \end{pmatrix} = L \begin{pmatrix} E_{bw} \\ E_{fw} \end{pmatrix}$$

$$E_R(A) = rE_I(A) + t'E_{bw}(A)$$

$$E_{fw}(A) = rE_I(A) + r'E_{bw}(A)$$

$r, r'$ 과  $t, t'$ 는 매질로 들어갈 때와 매질에서 나올 때의 Fresnel 반사계수와 투과계수

$$r = (n_0 - n) / (n_0 + n) = -r'$$

$$t = 2n_0 / (n_0 + n)$$

$$t' = 2n / (n_0 + n)$$

$$\begin{pmatrix} E_{bw} \\ E_{fw} \end{pmatrix}_A = \begin{pmatrix} e^{i\phi} & 0 \\ 0 & e^{-i\phi} \end{pmatrix} \begin{pmatrix} E_{bw} \\ E_{fw} \end{pmatrix}_B = \Phi \begin{pmatrix} E_{bw} \\ E_{fw} \end{pmatrix}_B$$

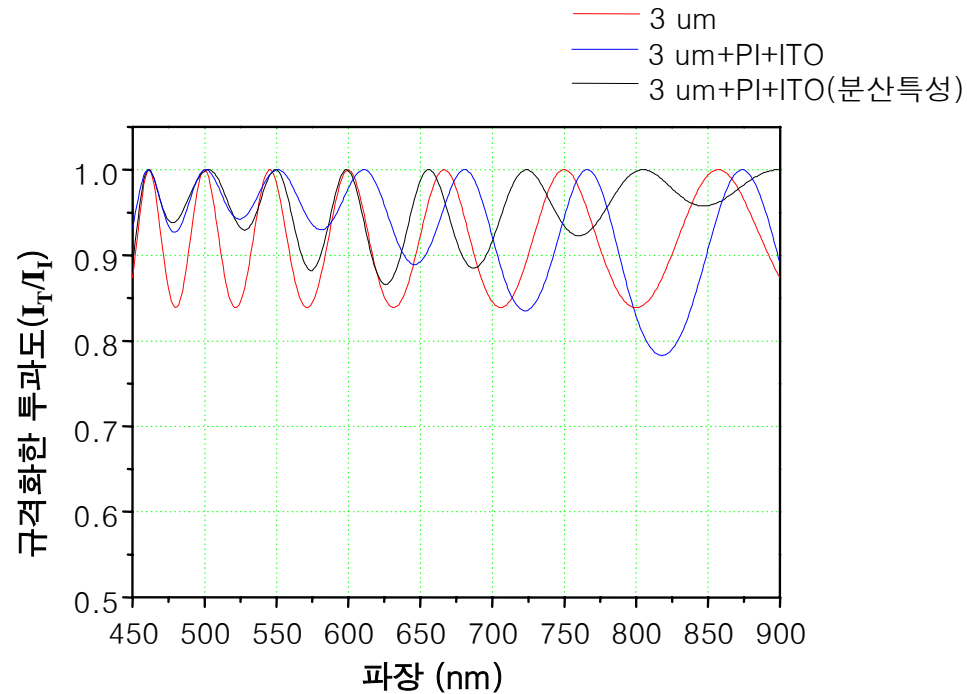
$\phi$  : 박막을 통과하는 동안에 생기는 위상변화,  $2\pi nd / \lambda$

다중박막의 경우: 각각의 박막에 대하여 행렬 L과  $\Phi$ 를 구하여 계산.



# Measurement principle : Empty Cell-Gap (5/5)

- 다층박막(PI, ITO)의 Simulation

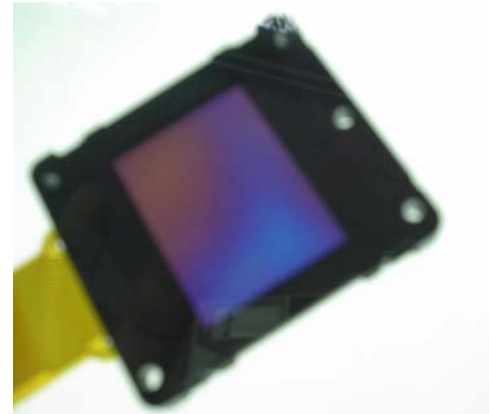


# Measurement principle : Filled Cell-Gap (1/2)

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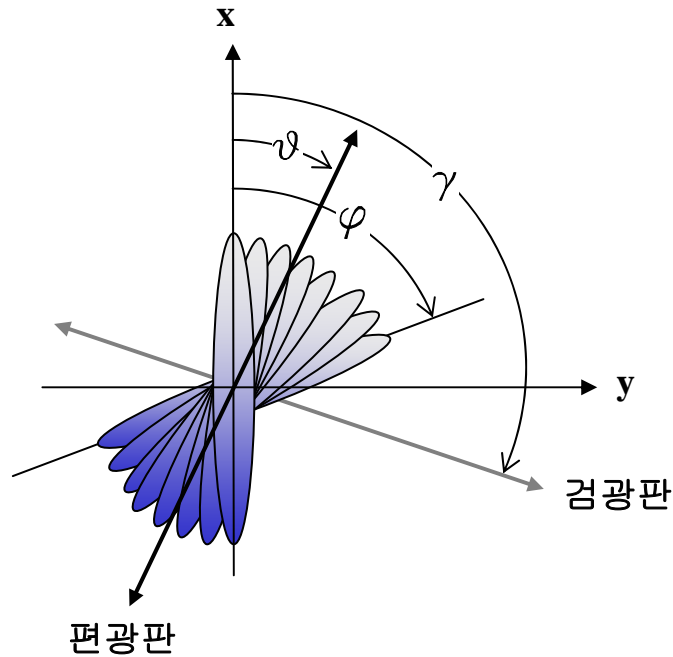
- Filled Cell-Gap의 기본 원리 : 편광투과특성의 파장 의존성

- 위상변화[ $=2\pi(\Delta n)d/\lambda$ ]가 파장의 함수
    - 파장에 따라 편광상태가 다름.
    - 투과도 차이
  - 액정분자의 색분산 [ $\Delta n(\lambda)$ ]
- => 파장에 따라 투과도가 다름



# Measurement principle : Filled Cell-Gap (2/2)

- TN, STN, ECB, IPS mode 측정 원리



$$I = [\cos(\beta) \cos(\vartheta - \gamma) + \frac{\varphi}{\beta} \sin(\beta) \sin(\vartheta - \gamma)]^2 + \frac{u^2}{u^2 + 1} \sin^2(\beta) \cos^2(\vartheta - \gamma)$$

$$\beta \equiv \varphi \sqrt{u^2 + 1}$$

$$u \equiv \frac{\pi(\Delta n)d}{\lambda\varphi}$$

$$I_{\parallel} = I(\vartheta = \frac{\pi}{4}, \gamma = \frac{\pi}{4})$$

$$I_{\perp} = I(\vartheta = \frac{\pi}{4}, \gamma = \frac{3\pi}{4})$$

# Measurement principle : Filled Cell-Gap (2/2)

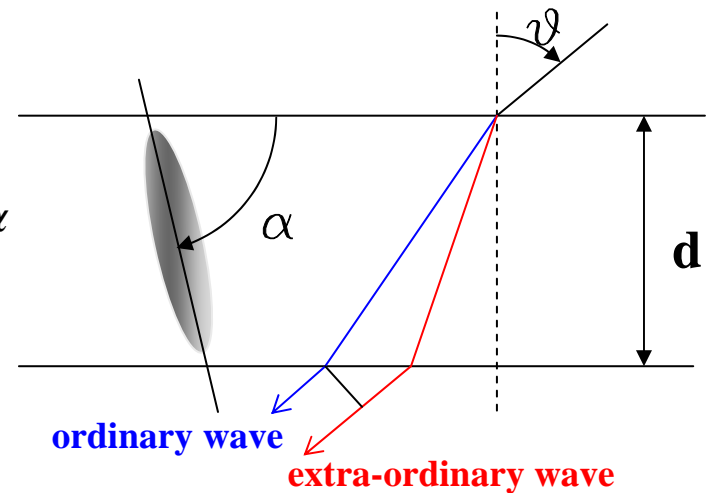
- VA mode 측정 원리 : LCD Cell의 경사 편광투과특성

Phase difference  $\delta(\vartheta, d)$

$$\delta(\vartheta, d) = \frac{2\pi d}{\lambda} \left\{ \frac{1}{c^2} (a^2 - b^2) \cos \alpha \sin \alpha \sin \vartheta + \frac{1}{c} \left( 1 - \frac{a^2 b^2}{c^2} \sin^2 \vartheta \right)^{1/2} - \frac{1}{b} \left( 1 - b^2 \sin^2 \vartheta \right)^{1/2} \right\}$$

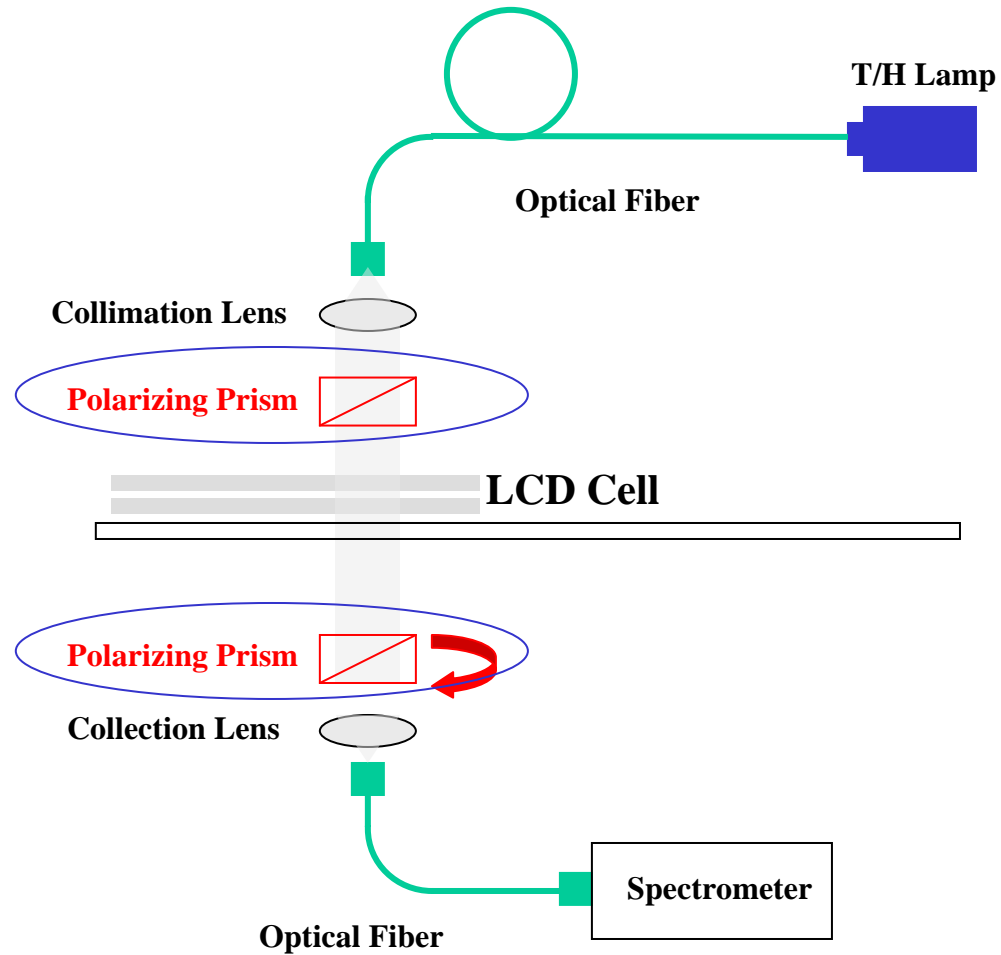
$$a = \frac{1}{n_e}, \quad b = \frac{1}{n_o}, \quad c^2 = a^2 \cos^2 \alpha + b^2 \sin^2 \alpha$$

$$T_{\text{par}} \propto \sin^2 \left( \frac{\delta(\vartheta, d)}{2} \right)$$



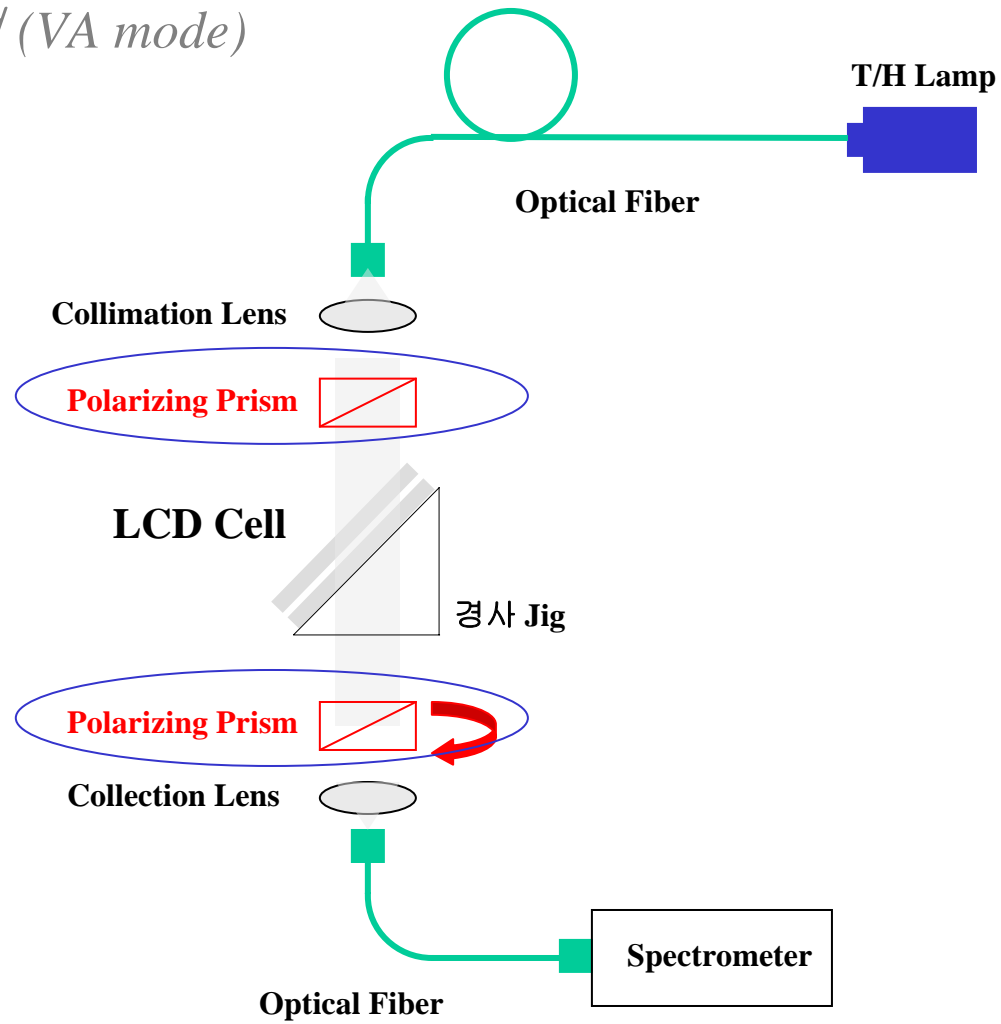
# System Block Diagram

- 수직 투과형

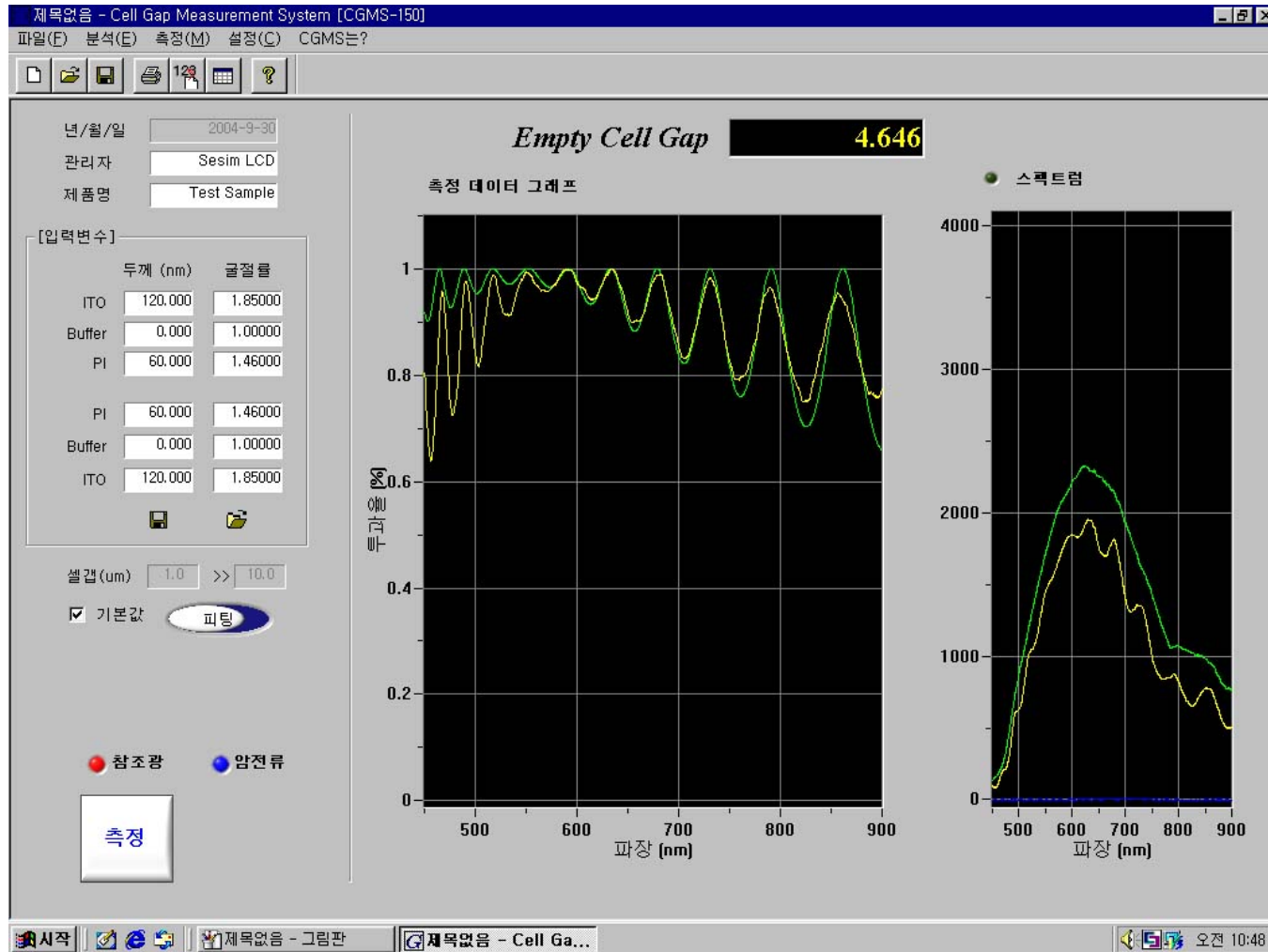


# System Block Diagram

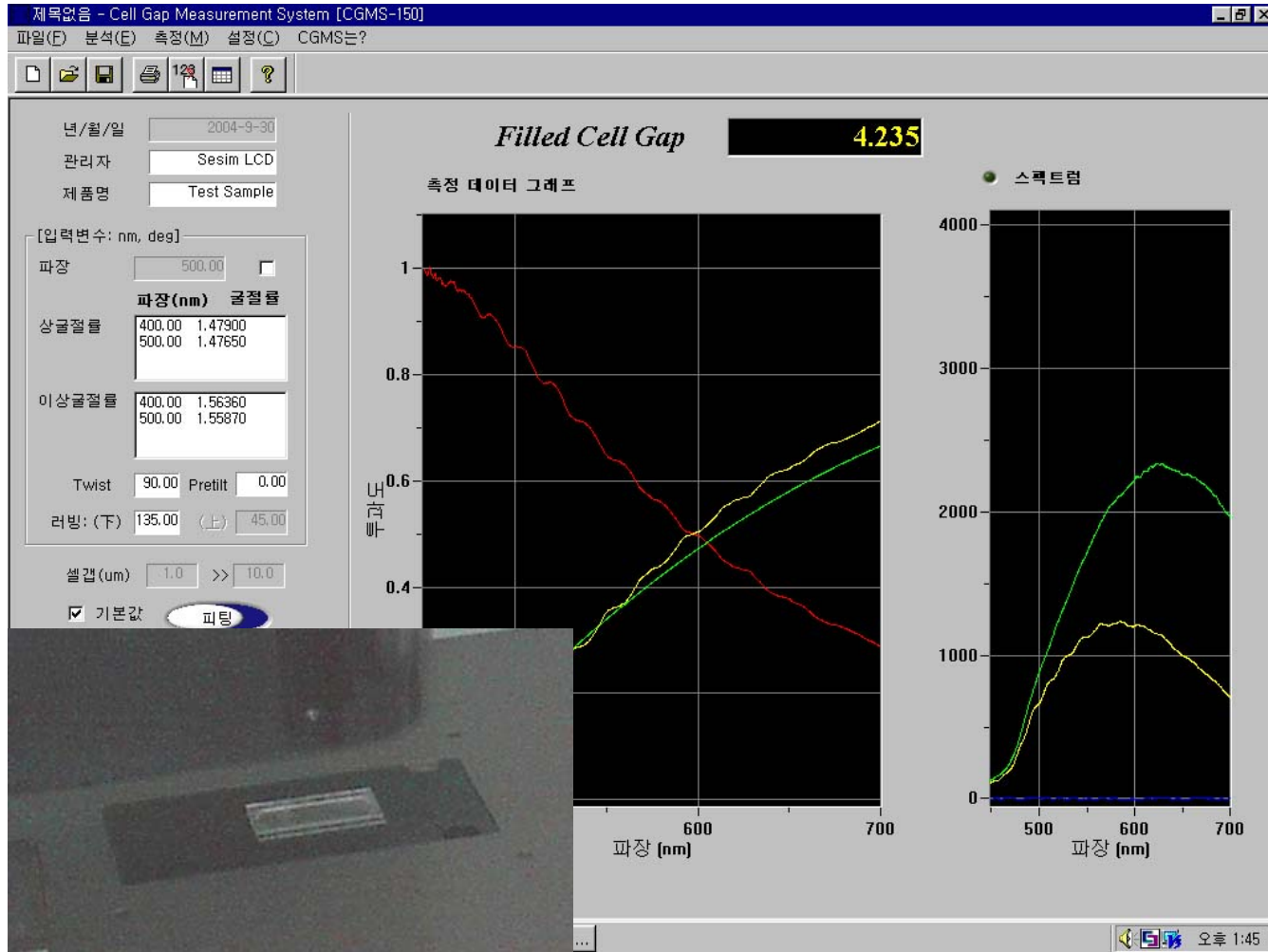
- 경사 투과형 (VA mode)



# Sample 측정 : Empty Cell-Gap



# Sample 측정 : Filled Cell-Gap (TN mode)





# Sample 측정 : Filled Cell-Gap (VA mode)

