APPENDIX

ERROR ANALYSIS

In a general relationship, the error of a quantity such as \( Z \) can be derived as the following. Let \( z \), \( a \), \( b \) and \( c \) be numerical values of the physical quantities \( Z \), \( A \), \( B \) and \( C \) and \( k \) being a constant.

\[
Z = k \times A^n \times B^m \times C^p \\
z = k \times a^n \times b^m \times c^p
\]

Taking logarithms to base e;

\[
\ln (z) = \ln (k) + \ln (a^n) + \ln (b^m) + \ln (c^p) \\
\ln z = \ln k + n \ln a + m \ln b + p \ln c
\]

Differentiating,

\[
\frac{1}{z} \delta z = n(1/a) \delta a + m(1/b) \delta b + p(1/c) \delta c
\]

Thus,

\[
\text{% error in } Z = n(\text{% error in } A) + m(\text{% error in } B) + p(\text{% error in } C)
\]

A1 : Refractive index (\( n \))

The refractive index of thin films on transparent substrate was given in equation 3.2.

\[
n(\lambda) = \left[ N + (N^2 - n_o^2 n_l^2)^{1/2} \right]^{1/2}
\]

with \( N = (n_o^2 + n_l^2)/2 + 2 n_o n_l [\big( T_M - T_m \big) / T_M T_m] \)
n is a function of $T_M$ and $T_m$. Thus the maximum possible error in $T_M$ and $T_m$ is

$$\left[ \frac{\Delta T_{\text{max}}}{T_{\text{max}}} \right] = \left[ \frac{\Delta T_{\text{min}}}{T_{\text{min}}} \right] = 0.01$$

$$\left[ \frac{\Delta N(\lambda)}{N(\lambda)} \right]^2 = \left[ \frac{(\Delta T_{\text{max}} + T_{\text{min}})}{T_{\text{max}}} \right]^2 + \left[ \frac{\Delta T_{\text{max}}}{T_{\text{max}}} \right]^2 + \left[ \frac{\Delta T_{\text{min}}}{T_{\text{min}}} \right]^2$$

$$= 1 \times 10^{-4}$$

$$\left[ \frac{\Delta n(\lambda)}{n(\lambda)} \right]^2 = \left[ \frac{\Delta N(\lambda)}{N(\lambda)} \right]^2$$

$$= 1 \times 10^{-4}$$

$$\left[ \frac{\Delta n(\lambda)}{n(\lambda)} \right] = 0.01$$

**A2: Film thickness ($d$)**

$$d = \frac{m\lambda}{2n}$$

Therefore

$$(\Delta d/d) = (\Delta n/n)^2$$

$$= 0.01$$

**A3: Optical energy gap ($E_g$)**

The optical energy gap was deduced from the intercept at the energy axis of the Tauc’s plot. Therefore $E_g = C/m$ where $C$ is the intercept on the y-axis and $m$ is the gradient of its linear portion.

$$\left[ \frac{\Delta E_g/E_g}{E_g} \right]^2 = \left[ \frac{\Delta C}{C} \right]^2 + \left[ \frac{\Delta m}{m} \right]^2$$

From the least square method,

$$\left[ \frac{\Delta C}{C} \right] = 0.002$$

$$\left[ \frac{\Delta m}{m} \right] = 0.01$$

Therefore,

$$\left[ \frac{\Delta E_g/E_g}{E_g} \right] = 0.01$$
A4 : Integrated intensity (I)

\[ I = S/\omega_o \]
\[ [\Delta I/I]^2 = [\Delta S/S]^2 \]

Thus,
\[ [\Delta I/I] = [\Delta S/S] \]
\[ = 0.05 \]

A5 : Hydrogen content (H%)

From equation 3.13,
\[ H\% = \frac{N(H)}{N_{Si}} = \frac{N(H)}{(5 \times 10^{22})} \]

Therefore,
\[ [\Delta H\% / H\%] = [\Delta N/N] \]
\[ = 0.05 \]

A6 : Microstructure parameter (R)

From equation 3.12,
\[ R = \left[ \frac{l_{2100}}{(l_{2100} + l_{2000})} \right] \]
\[ [\Delta R/R]^2 = \left[ \frac{\Delta l_{2100}}{l_{2100}} \right]^2 + \left[ 2(\Delta l_{2100} + \Delta l_{2000})/(l_{2100} + l_{2000}) \right]^2 \]
\[ [\Delta R/R]^2 \equiv \left[ \Delta l_{2100}/l_{2100} \right]^2 \]

Thus \[ [\Delta R/R] = 0.05 \]
Appendix

A7: Urbach tail bandwidth \((E_e)\)

The Urbach tail bandwidth is deduced from the slope of the linear part of plot \(\ln \alpha\) versus \(E\) near the absorption edge. Thus \(E_e = 1/m\) where \(m\) is the slope.

Therefore, \((\Delta E_e/E_e) = (\Delta m/m)\)

From least square root method,

\((\Delta m/m) = 0.01\)

Thus, \((\Delta E_e/E_e) = 0.01\)