Appendix B

Error Analysis

In most experiments the final quantity Z is not measured directly instead Z is determined from the measurement of certain primary quantities like A, B, C, etc. The general rule [92] states that if Z be a known function of A, B, C,... the standard error in A is given by ΔA and so on. Thus the standard error in Z, ΔZ is given by,

$$(\Delta Z)^2 = (\Delta Z_A)^2 + (\Delta Z_B)^2 + (\Delta Z_C)^2 + \ldots,$$

where

$$(\Delta Z_A) = \left(\frac{\partial Z}{\partial A}\right)\Delta A \text{ and so on.}$$

A.1 Refractive Index [n(λ)]

$n(\lambda) = [N + (N^2 - n_0 n_1)^{1/2}]^{1/2}$

where

$$N(\lambda) = \frac{n_0^2 + n_1^2}{2} + 2n_0 n_1 \frac{T_{max}(\lambda) + T_{min}(\lambda)}{T_{max}(\lambda).T_{min}(\lambda)}$$

$$\left[\frac{\Delta T_{max}}{T_{max}}\right] = \left[\frac{\Delta T_{min}}{T_{min}}\right] = 10^{-2}$$

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

$= 6 \times 10^{-4}$

$$\left[\frac{\Delta n(\lambda)}{n(\lambda)}\right]^2 = \left[\frac{\Delta N(\lambda)}{N(\lambda)}\right]^2 = 6 \times 10^{-4}$$

$$\left[\frac{\Delta n}{n}\right] = 0.02$$

A.2 Thickness:

$$\Delta d = \sqrt{\frac{\sum (d - d^1)^2}{N(N-1)}}$$

$\Delta d = \pm 4.33$

A.3 Hydrogen Percentage (Valence Electron Model)

The hydrogen percentage calculated by valence electron model is a function of dispersion energy E_d and number of free valence electron n_V. Hence the error in E_d and n_V are determined primarily.

The basic expression for the calculation of E_d is given as,

$$\left(n^2 - 1\right) = \frac{E_d E_0}{\left[E_d^2 - (\hbar\omega)^2\right]}$$

E_d is obtained from the slope (m) and intercept (C) of the linear portion of the plot of $[1/n^2\text{-}1]$ verses $(h\,\omega)^2$.

$$E_d = \sqrt{\frac{C}{m}}$$

$$\left[\frac{\Delta C}{C}\right] = 2.83 \times 10^{-4}$$

$$\left[\frac{\Delta m}{m}\right] = 1.68 \times 10^{-3}$$

$$\left[\frac{\Delta E_d}{E_d}\right]^2 = \left[\frac{\Delta C}{C}\right]^2 + \left[\frac{\Delta m}{m}\right]^2 = 2.91 \times 10^{-6}$$

$$\left[\frac{\Delta E_d}{E_d}\right] = 1.71 \times 10^{-3}$$

$$n_V = 0.0143 \frac{E_d^2}{\varepsilon(0) - 1} \times 10^{23}$$

$$\varepsilon_0 = n^2(1100)$$

where

$$\left[\frac{\Delta n_V}{n_V}\right]^2 = 2\left[\frac{\Delta E_d}{E_d}\right]^2 + 4\left[\frac{\Delta n}{n}\right]^2$$

$$= 1.76 \times 10^{-4}$$

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

Hydrogen Percentage = $C_H = \frac{1}{3}\frac{n_V}{n_S}\left(4 - \sqrt{\frac{E_d}{2.8}}\right) \times 100$

$$\left[\frac{\Delta C_H}{C_H}\right]^2 = \left[\frac{\Delta n_V}{n_V}\right]^2 + \frac{1}{2}\left[\frac{\Delta E_d}{E_d}\right]^2$$

$$= 1.01 \times 10^{-4}$$

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

A.4 Optical Energy Gap:

The Optical energy gap E_g is obtained from the intercept and slope of the plot of

$((\alpha h\nu)^{1/2}$ verses$(h\nu)$. as ,

$E_g = \frac{C}{m}$, where C is the intercept on the Y-axis and m is the gradient of the linear portion of the above plot.

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

$$= (2.56 \times 10^{-3})^2 + (1 \times 10^{-2})^2$$

$=1.68\times10^{-4}$

$$\left|\frac{\Delta E_g}{E_g}\right| = 0.01$$

A5 Conductivity (σ)

$$\sigma = \frac{I}{V}\times\frac{d}{A} = (\text{slope})\frac{d}{w\times t}$$

$$\left[\frac{\Delta\sigma}{\sigma}\right]^2 = \left[\frac{\Delta \text{slope}}{\text{slope}}\right]^2 + \left[\frac{\Delta d}{d}\right]^2 + \left[\frac{\Delta t}{t}\right]^2 + \left[\frac{\Delta w}{w}\right]^2$$

$$=[.005855]+[0.0025]+[3.8\times10^{-6}]+[0.000224]$$

$$=0.002763$$

$$\left[\frac{\Delta\sigma}{\sigma}\right] = 0.05$$

A6 Activation Energy (E_C-E_F)

E_C-E_F=$K\times S_I$

Where S_I is the gradient of the first slope

$$\left[\frac{\Delta(E_C - E_F)}{E_C - E_F}\right] = \left[\frac{\Delta S_I}{S_I}\right] = 0.03$$

A7 Density of States at the Fermi level:

$$N(E_f) = \left(\frac{8^3\pi^3K^4}{9^3e^{12}\nu^6\lambda}\right)^{1/2} T_0^{1/2}\sigma_I^3$$

$$\left[\frac{\Delta N(E_f)}{E_f}\right]^2 = \frac{1}{2}\left[\frac{\Delta T_0}{T_0}\right]^2 + 3\left[\frac{\Delta\sigma_I}{\sigma_I}\right]^2$$

where T_0 and σ_l are computed from the slope and intercept respectively of the plot of ($\ln\sigma\sqrt{t}$) verses ($T^{-1/4}$).

$$\left[\frac{\Delta N(E_f)}{E_f}\right]^2 = \frac{1}{2}\left[\frac{\Delta \text{Slope}}{\text{Slope}}\right]^2 + 3\left[\frac{\Delta \text{Intercept}}{\text{Intercept}}\right]^2$$

$$=0.000405 + 0.00000177$$

$$=0.00040677$$

$$\left|\frac{\Delta N(E_f)}{E_f}\right| = 0.020$$