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OPTICAL APSORPTION IN ORGANIC SEMICONDUCTORS AND THEIR IMPURITIES

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The approximately pure organic semiconductors such as anthracene and naphthalene, can be refined up to 100% purity with the help of zone refining methods[1,2,3] by passing the sample several times through the refining process. Also we can study the distribution of impurity in the sample with the help of a spectrophotometer by plotting different concentrations against optical absorption. In most cases we get a straight line. If we suppose that for any impurity the angle of that line with the x-axis is Θ_1; then, we can write

$$m_1 = \tan \Theta_1 = \frac{\delta d_1}{\delta c_1}, \tag{1}$$

where d and c represent the optical absorption and concentration respectively.

Now, if we take sample 100% pure and keep the other experimental factors constant, then we get

$$m_2 = \tan \Theta_2 = \frac{\delta d_2}{\delta c_2}. \tag{2}$$

Now again, adjusting the percentage of second impurity in the sample by making several trials, we get a straight line making an angle Θ_1 with the x-axis under the same experimental conditions; then

$$m_3 = \tan \Theta_1 = \frac{\delta d_3}{\delta c_3}. \tag{3}$$

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From Equs. (1) and (3) we get

$$m_3 = m_1 = \tan\Theta_1 = \frac{\delta d_3}{\delta c_3} = \frac{\delta d_1}{\delta c_1}. \tag{4}$$

Now if

$$(\delta d_2 \sim \delta d_1) = \Delta d', \quad (\delta c_2 \sim \delta c_1) = \Delta c',$$

and

$$(\delta d_2 \sim \delta d_3) = \Delta d'', \quad (\delta c_2 \sim \delta c_3) = \Delta c'',$$

then

$$m' = \frac{\Delta d'}{\Delta c'} = \frac{(\delta d_2 \sim \delta d_1)}{(\delta c_2 \sim \delta c_1)}. \tag{5}$$

Similarly

$$m'' = \frac{\Delta d''}{\Delta c''} = \frac{(\delta d_2 \sim \delta d_3)}{(\delta c_2 \sim \delta c_3)}. \tag{6}$$

From equations (2) and (4) we have;

$$(m_2 - m_1) = \left(\frac{\delta d_2}{\delta c_2} - \frac{\delta d_1}{\delta c_1}\right) = D' \left(\frac{\delta d_2 \sim \delta d_1}{\delta c_2 \sim \delta c_1}\right),$$

or

$$(m_2 - m_1) = D' m'. \tag{7}$$

Similarly we have

$$(m_2 - m_3) = D'' m''. \tag{8}$$

But $m_1 = m_3$ from Equ. (4) so that

$$(m_2 - m_1) = D'' m''. \tag{9}$$

Comparing Equs. (7) and (9) we get

$$D' m' = D'' m'', \tag{10}$$

and

$$D^{(n-1)'}\, m^{(n-1)'} = D^{n'}\, m^{n'}.$$

Or

$$\frac{D^{(n-1)'}}{D^{n'}} = \frac{m^{n'}}{m^{(n-1)'}}.$$

Where D is a constant, which can be called as the cofficient of optical absorption due to any impurity in a organic-semiconductor with respect to another impurity, and thus we can compare different impurites with respect to one another in different organic-semiconductors very easily and thus can choose the best suited combination for a particular purpose.

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