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MODEL EQUATIONS FOR PREDICTING THE RELATIONSHIP BETWEEN DYE/ANODE THICKNESS AND TIME

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Abstract

In an earlier study, graphical representation of the relationship between the dye thickness (s) and time (t), as well as the relationship between the anode thickness (T) and time were investigated. Here in this work, the aim is to obtain model equations that could best describe those graphical relationships between the dye thickness (s) and time (t), as well as between the anode thickness (T) and time (t). The result of this study was the generation of the model equations for predicting the behavior of the curves under investigation.

***Keywords*:** model, equations, predict, relationship, dye, anode

1. INTRODUCTION

Model equations can be said to be ideal equations that can be used to represent a particular occurrence or relationship. The above statement was made following the dictionary meaning of the word: 'model' [1]. The model equations generated in this work can be said to be a simplified representation of the figures investigated. According to an unnamed source, an ideal model can help one understand how to solve equations that have variables on both sides [2].The use of mathematical equations/functions to describe physical phenomenon or physical relationship did not just evolve. It has been on for a long time now [3, 4].

Efurumibe et al did a work in 2012 with the aim of relating the dye thickness (s) as well as the anode thickness (T) of a standard dye-sensitized solar cell with time [5]. The revised version of the work done by Efurumibe et al was published in 2014 in International journal of Engineering and Technology Studies. In their work, Efurumibe et al obtained graphical representation of the relationship between the dye thickness (s) and time (t); as well as the relationship between the anode thickness (T) and time. Here in this work, the aim is to obtain model equations that could serve as functions of those graphical relationships between the dye thickness (s) and time (t), as well as between the anode thickness (T) and time (t).The figures whose model equations were obtained are Figs. 1 – 5. These figures were represented in this work for better understanding of the concept being discussed. At the end, the model equations where obtained and the square of their regression coefficient, R^2 obtained as well.

2. THE FIGURES BEING CONSIDERED

The figures which show the relationship between the dye thickness (s) and time (t); as well as the relationship between the anode thickness (T) and time, as contained in Efurumibe et al's work were supplied in Figs. 1 – 5 below:

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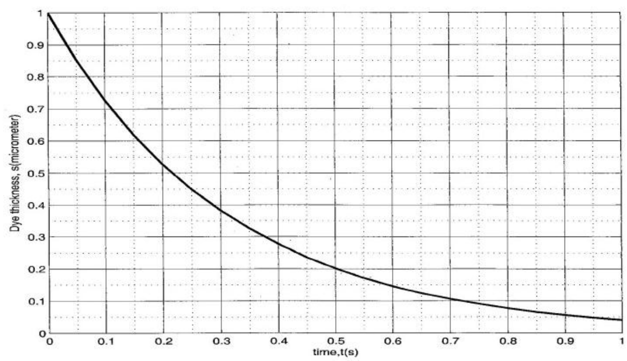

Fig. 1: Graph of dye thickness, s against time (t) plotted for time 0 to 1 second in time step of 0.05s

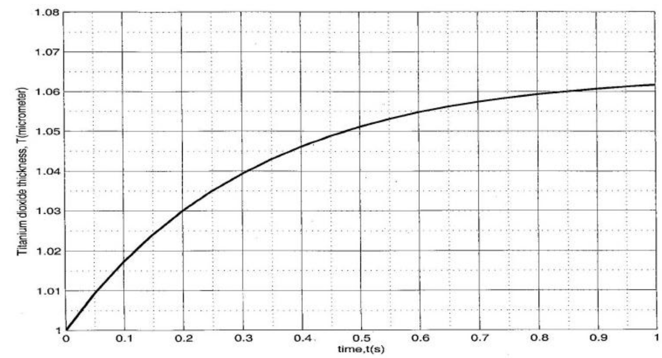

Fig.2: Graph of titanium dioxide thickness, T against time (t) plotted for time 0 to 1 second in time step of 0.05s

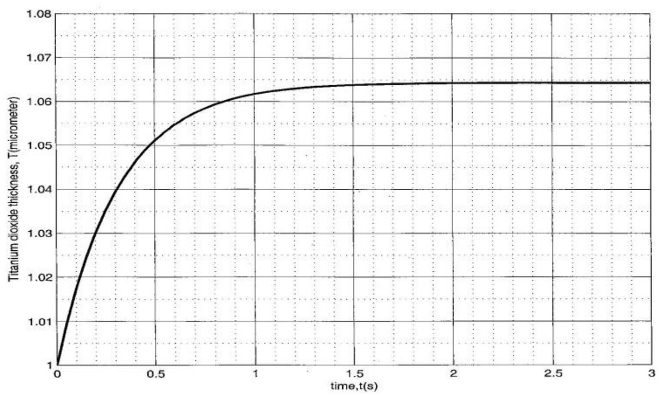

Fig.3: Graph of titanium dioxide thickness, T against time (t) plotted for time 0 to 3 seconds in time step of 0.05s

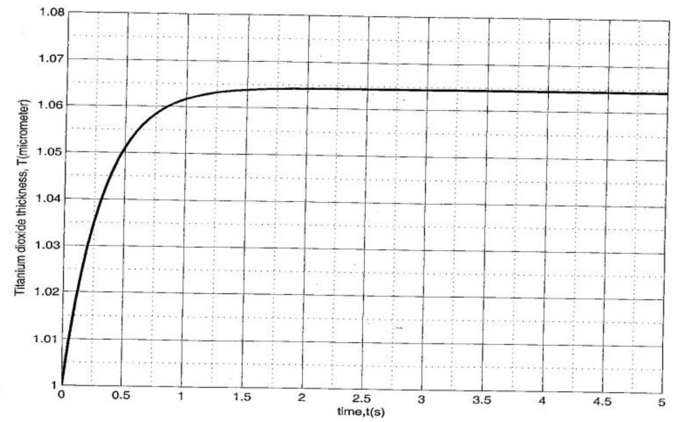

Fig.4: Graph of titanium dioxide thickness, T against time (t) plotted for time 0 to 5 seconds in time step of 0.05s

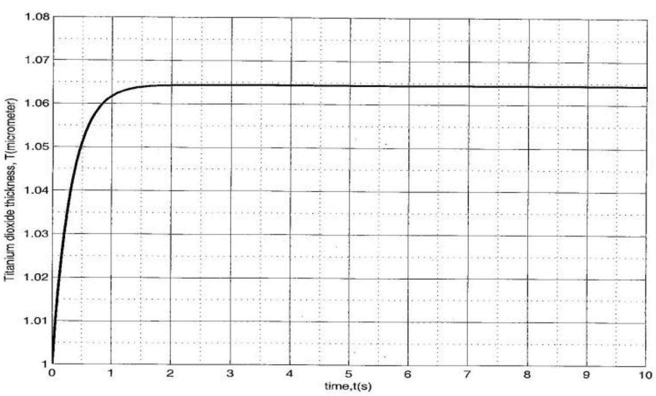

Fig.5: Graph of titanium dioxide thickness, T against time (t) plotted for time 0 to 10 seconds in time step of 0.05s

3. THE METHOD ADOPTED IN OBTAINING THE MODEL EQUATIONS

The model equations were obtained by first considering various points along each of the curve, so as to obtain the values corresponding to the dye thickness and time (for the figure showing the relationship between the dye thickness and time)[6]. Similar steps were taken for Fig. 2 – 5. After these, the values were used in Microsoft excel worksheet to obtain the same curves presented by Figs. 1 – 5. Afterwards trend lines were matched to fit the curves generated. With this the excel worksheet generated an appropriate function for each of the curves. The square of the regression coefficient gives one an idea of the function (in this study the word: 'equation' was majorly used) out of the many generated that best described the curve under investigation.

4. RESULTS

The results of the investigation were supplied in Table 1. Table 1 shows the functions (equations) that best describe the relationships between the dye thickness (s) and time (t), as well as between the anode thickness (T) and time (t).

Table 1: Model equations for prediction

S/N	Figures	Model Equations	R^2
1.	1	$s = 0.962e^{-2.04t}$	0.978
2.	2	$T = 0.019\ln(t)+1.055$	0.995
3.	3	$T = 0.018\ln(t)+1.049$	0.892
4.	4	$T = 0.008\ln(t)+1.054$	0.746
5.	5	$T = 0.005\ln(t)+1.055$	0.612

Where s = dye thickness and T = anode thickness

The square of the regression coefficient, R^2 nearing one shows a near perfect relationship between the variables under investigation.

5. DISCUSSION

The square of the correlation coefficients (in Table 1) for the model equations for prediction shows a near perfect correlation, meaning that the mathematical model is a good representation of the electron transport through the anode of the standard dye-sensitized solar cell. The model equation no.1 can predict near perfectly values of 's' for a range of time, t from: 0.1 to 0.33 in seconds. Next, the model equation no.2 can predict near perfectly values of T for a range of time, t from: 0.2 to 0.8 in seconds. The model equation no.3 can predict near perfectly values of T for a range of time, t from: 0.5 to 2 in seconds. The model equation no.4 can predict near perfectly values of T for a range of time, t from: 1 to 3.5 in seconds. The model equation no.5 can predict near perfectly values of T for a range of time, t from: 1 to 5 in seconds. Earlier, it was established that the efficiency, Eof a dye-sensitized solar cell is directly proportional to the thickness of the anode of the cell[7]. This means that if the thickness of the anode is increased say up to 10000μm (equivalent to 1cm), efficiency of the cell would invariably increase. The problem will lie in the ability to increase the anode thickness up to 1cm. This will require a special glass plate to achieve that.

6. CONCLUSION

The model equations generated can be said to be a good model for the relationship between the dye thickness and time as well as anode thickness and time. The equations can predict perfectly the relationship between the dye thickness and time as well as anode thickness and time within the limit covered by the curve of Fig. 1 to 5. Thus the conclusion here is that, the model equations are good functions of the respective curves given by Fig. 1 to 5; and these equations should be upheld so long as the work done by Efurumibe et al (in 2012) is concerned.

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