Mathematical Modelling and Analysis
Abstracts of the 9th International Conference MMA2004, May 29-31, 2004, Jūrmala, Latvia

MODELLING AMPEROMETRIC BIOSENSORS ACTING IN A TRIGGER MODE

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A biosensor is considered as an enzyme electrode, containing a membrane with immobilised enzymes applied onto the electrochemical transducer [1]. We consider a trigger enzymatic scheme where the substrate S is enzymatically converted to the product P_1 followed by the electrochemical conversion of the product P_1 to another product P_2 that in turn is enzymatically converted back to P_1 [2]. The biosensor action was described by the reaction-diffusion system ($t > 0$)

$$\frac{\partial S}{\partial t} = D_S \frac{\partial^2 S}{\partial x^2} - \frac{V_1 S}{K_1 + S}, \quad \frac{\partial P_2}{\partial t} = D_{P_2} \frac{\partial^2 P_2}{\partial x^2} - \frac{V_2 P_2}{K_2 + P_2}, \tag{1}$$

$$\frac{\partial P_1}{\partial t} = D_{P_1} \frac{\partial^2 P_1}{\partial x^2} + \frac{V_1 S}{K_1 + S} + \frac{V_2 P_2}{K_2 + P_2}, \quad x \in (0, d), \tag{2}$$

$$S(x,0) = P_1(x,0) = P_2(x,0) = 0, \quad x \in [0, d), \tag{3}$$

$$S(d,0) = S_0, \quad P_1(d,0) = P_2(d,0) = 0, \tag{4}$$

$$\left.\frac{\partial S}{\partial x}\right|_{x=0} = 0, \quad D_{P_2} \left.\frac{\partial P_2}{\partial x}\right|_{x=0} = -D_{P_1} \left.\frac{\partial P_1}{\partial x}\right|_{x=0}, \tag{5}$$

$$S(d,t) = S_0, \quad P_1(0,t) = P_1(d,t) = P_2(d,t) = 0, \tag{6}$$

where x and t stand for space and time, $S(x,t)$ is the concentration of the substrate S, $P_i(x,t)$ is the concentration of the product P_i, d is the thickness of the enzyme membrane, D_S and D_{P_i} are the diffusion coefficients, V_i is the maximal enzymatic rate, K_i is the Michaelis constant, $i = 1, 2$.

The the problem (1)-(6) was solved numerically by applying the finite difference technique. The influence of the substrate concentration, the maximal enzymatic rate and the membrane thickness on the biosensor response was investigated.

REFERENCES

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