Electrochemical Quartz Crystal Microbalance Study of Protein Adsorption on the Poly(pyrrole)-Biotin Modified Electrodes

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In a human body, albumin is responsible, among others, for isolation of any foreign intruding solid object. Thus, implants can be clogged and rejected. Therefore, we have undertaken an effort to find conditions, in vitro, under which adsorption of albumin is a solid substrate surface is prevented. Virtually, albumin does not interact with avidin. Therefore, an idea was explored to coat, first, the studied solid surface with avidin in hope that albumin will not adsorb onto it afterwards. For effective adsorption of avidin, we used an avidin-biotin immobilization technology.

Adsorption of the proteins on a solid substrate was investigated by using electrochemically aided selective piezoelectric microgravimetry at an electrochemical quartz crystal microbalance (EQCM 5510, Institute of Physical Chemistry, Warsaw). Our idea was to use a matrix of a conducting polymer for biotin (Inset in Fig. 1) immobilization by ion exchange. That is, the surface of a gold electrode of the 5 MHz resonant frequency quartz crystal piezoelectric transducer was coated with a poly(pyrrole) film by electropolymerization in aqueous solution of pH close to 9, in the presence of biotin. Under this solution conditions, biotin was dissociated to form anion, which entered the film as counter ion for charge compensation of electro-oxidized poly(pyrrole). Growth of the biotin-doped conducting polymer film was monitored by simultaneous measurements of cyclic voltammetry and piezoelectric microgravimetry under quiescent solution conditions.

Then, the avidin adsorption was studied under flow injection analysis (FIA) conditions by using the coated with the biotin ion-exchanged poly(pyrrole) film. Consecutive injections of the avidin solution samples resulted in steps rather than peaks in the curve of the frequency change with time (Fig. 1) indicating that, presumably, avidin irreversibly interacted with the biotin sites immobilized in the poly(pyrrole) film. The height of these steps decreased with the injection number as the biotin sites became gradually saturated. Our preliminary results of the FIA experiments indicate that the avidin layer immobilized onto the poly(pyrrole)-biotin film prevented adsorption of albumin.

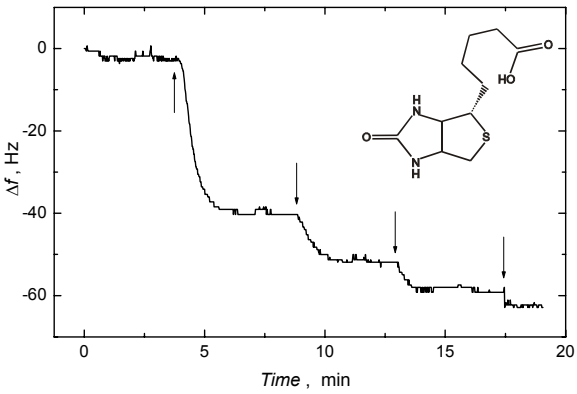

Fig. 1 A curve of the resonant frequency change with time for four consecutive injections (indicated with arrows) of 0.1 ml samples of 0.1 mg ml^{-1} avidin to water flowing at 40 μl min^{-1}; 5 MHz, 14 mm quartz crystal coated with a film of poly(pyrrole) doped with biotin.