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Nanostructured screen-printed electrodes for immunosensor

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Abstract – Gold nanoparticles have been distributed by chemisorption interaction in a three dimensional structure of MTMPS sol-gel. This novel feature of modified electrodes has been mounted on screen-printed gold electrodes and it is being used to detect biomolecules interactions. Through a small variation of an electrical signal under the modified electrode one can build a model that describes a specific antigen-antibody binding. Electrochemistry impedance spectroscopy has found to be an effective analysis that transduces this electrical signal. In the present work, we have been exploiting these three concepts to create an innovative method for diagnosis of important bovine diseases by immunoassay.

Good animal health is an important determinant of economic productivity around the world. To Brazil is not different. Bovine diseases cause important losses to the economy of our country every year. Traditional laboratory techniques used to isolate, culture, and identify organisms are labour, intensive and expensive, and they require considerable capability and equipment. The indirect enzyme-linked immunosorbent assay (ELISA) is one of these techniques commonly used in serological diagnosis of most of diseases. The development of methods targeting the direct monitoring of antibody–antigen interactions is particularly attractive. The design of affinity-based probing concepts and label-free assay are the objective of much current research, on the way to establish alternative methods to the already conventional existing [1]. Electrochemical impedance spectroscopy (EIS) has been proven as one of the most powerful tools for examination of interfacial reactions [2]. EIS measures the response of an electrochemical system to an applied oscillating potential as a function of the frequency. Based on the charge-transfer kinetics of the $[Fe(CN)_6]^{3-/4-}$ redox couple, Faradaic impedance spectra with an $Fe(CN)_6^{3-/4-}$ redox probe are modeled using the equivalent circuit approach of Randles. The components of this circuit describes the impedance in a system where the charge transfer between modified electrodes and a redox-active couple could occur at either pinhole defects in the 3-D structure, at which the redox couple can directly contact the metal surface, or by tunneling through “collapsed sites” [3]. Despite of the mechanism, the system with high *R*ct is more effective in preventing the redox probe from accessing the electrode, indicating a disordered layer with only partial coverage of the electrode surface or an intrinsically porous structure. The sol-gel of MPS develops a three-dimensional porous structure that has a high concentration of –SH [4]. Natan et al. [5] have shown that gold nanoparticles (AuNP) are strongly bound to the surface through covalent bonds to the polymer functional groups, such as -CN, $-NH_2$, or -SH, and a gold nanoparticle monolayer can be prepared by self-assembly on the hybrid organic-inorganic coated substrate. Therefore, AuNP can be assembled both inside the network and on the surface of the MPS sol-gel. This approach shows the benefits of self-assembly, NP and the increased surface area of three-dimensional electrodes. These nanoparticles can act as tiny conduction centers what can facilitate the transfer of electrons [4]. Additionally, biological macromolecules like proteins retain their activity when adsorbed on AuNP [6]. The recombinant protein MSP5 is antigenic protein to characterization of *Anaplasma marginale* and it has been used to develop diagnostic kits based on ELISA. This antigen is used in the construction of the device described here because the MSP5 has already have a good volume of research work at Embrapa Beef Cattle and represent to us a model in the present discussion. So, this protein has been immobilized on the nanostructured constituted of MPS sol-gel based-silica and gold nanoparticles. Until this moment we have got impedance analysis that corresponds to the reaction of MSP5 and its specific antibody resting on the modified electrode surface. Our major challenge has been to reproduce the preliminary results.

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