DIFFERENT RESPONSE FROM DIFFERENT ELECTRODES – AN APPLICATION IN COMPOSITION ANALYSING OF SOLUTION

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Abstract

The transient current response of electrodes is strongly dependent on the properties of electrodes and electrolytes. We use platinum and stainless electrodes respectively to analyze saline with different concentration of lactate. We can distinguish the small compositional difference of solution at a suitable condition. Our results suggest that the measurement of EAV can give the concentration of lactate at any specific point of the body.

Keywords: electrode, double layer, transient response, lactate, EAV.

Introduction

When an electric potential is applied on an electrode, it will cause a specific charge distribution at the electrode-electrolyte interface. This phenomenon induces the electrical double layer, and it has been studied by Helmholtz and followers [1]. The double layer is like a capacitance and will be built up after the potential is applied, but the induced current is strongly dependent on the material of electrode [2] and ingredients of electrolyte.

Recently we studied the transient current response of electrode immersed in the solution. After applying a step potential, we found that the transient response could tell us the composition of the solution and it make the measurement of EAV (Electro-acupuncture according to Voll) [3] more meaningful. This will be a useful method in medical diagnosis.

Methods and Materials

A pair of platinum electrodes in shape of cylindrical (1mm diameter) spaced 1cm apart were immersed 1cm into solution contained with a 4.2cm(O.D.) 50ml beaker, and connected to a constant voltage power supply by a mechanical relay which could be switched on in 0.1msec. The electrodes were supplied with 1.0 Volt step potential by operating the switch, and the transient current response through the cathode was analyzed on a personal computer by

an A/D converter in sampling rate of 6K/sec.

The solutions were saline (0.9% NaCl) with different concentrations of lactate from 10^{-2} M to 10^{-4} M. NaCl and lactate were from Sigma.

The same procedure was done with stainless electrodes (One is cone in shape, base radius $R=0.3$ mm height=2mm, the other is cylindrical with $R=1$ mm.) and IC (4051) switch which could be switched on in 10^{-6} sec in sampling rate 40k/sec.

All the experiment was done in condition of 25°C.

Result

The result of platinum electrodes is shown in fig.1. The different responses of solutions with different concentration of lactate could be distinguished clearly at this condition. The higher is the lactate concentration in the saline, the higher is the value of current.

The result of stainless electrodes is shown in fig2. Same as result of platinum electrodes, the higher is the lactate concentration in the saline, the higher is the value of current. However, The current response curves of pure saline (0.9%NaCl only) and saline with lactate of concentration 10^{-4} M could be divided clearly at this condition.

Fig. 1. Current response from platinum electrodes.

Fig. 2. Current response from stainless electrodes.

Discussion

STM (scanning tunneling microscopy) can see the surface structure of a sample by measuring the variation of electric field at local measured point. The detail surface structure of measured sample and work function of measured material will determine the distribution of electrical field, so does the number of electrons transferred and what we could see.

Water molecular have 2.3 hydrogen bonds per molecular on average with 4 to 6 adjacent molecular, and aggregate to form polyhedron. Pure water is in form of defected amorphous crystal by stacking of these polyhedra [4][5]. When we add some ions in pure water, these ions will be surrounded by several layers of water molecular, and break hydrogen bond supporting the structure. Water structure will be broken into many smaller aggregate centered by ion or polarized molecular like lactate.

Same as STM measurement, the local electric field on the electrode surface will control not only the process of the forming of the double layer, but the ability of the electron transferred from solution to electrode. This is why the transient current response can be different even if the material of electrode [6], composition of solution and surface of electrode, are a little changed. However, we can distinguish the small compositional difference of solution at a suitable condition, and our results suggest that the measurement of EAV can give the concentration of lactate at any specific point of the body.

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