

ing the cartridge in the receptacle, an electrical contact to the working electrode, a source of electrical energy for exciting ECL at the surface of the electrode, a light-detection device for measuring the emission of ECL, and a sonicating device, reversibly structurally coupled to the cartridge, for sonicating the contents of the cartridge.

[0023] According to still another aspect of the present invention, a method for carrying out electrochemiluminescence measurements is provided. The method includes the steps of introducing a sample comprising an electrochemiluminescent moiety into a cell including a working electrode; sonicating the sample in the cell with a sonicating device structurally coupled to the cell; and applying electrical energy to the electrode to cause the electrochemiluminescent moiety in the sample to luminesce.

[0024] According to yet another aspect of the present invention, a method for preparing an electrode in a cell or cartridge for use in electrochemiluminescence measurements is provided. The method includes sonicating the cell or cartridge with a sonicating device structurally coupled to the cell or cartridge so as to remove undesired contaminants from the surface of the electrode and to increase mass transport of desirable reagents to the surface of the electrode.

[0025] Other objects, features, and advantages according to the present invention will become apparent from the following detailed description of illustrated embodiments when read in conjunction with the accompanying drawings in which the same components are identified by the same reference numerals.

#### BRIEF DESCRIPTION OF THE DRAWINGS

[0026] FIG. 1 is a schematic diagram of an assay cell according to an embodiment of the present invention;

[0027] FIG. 2 is a schematic diagram of an assay cell according to another embodiment of the present invention;

[0028] FIG. 3 is a schematic diagram of an assay cell according to another embodiment of the present invention;

[0029] FIG. 4 is a schematic diagram of an assay cell according to yet another embodiment of the present invention;

[0030] FIG. 5 is a schematic diagram of an assay cell according to still another embodiment of the present invention;

[0031] FIG. 6 is a schematic diagram of an assay cell according to another embodiment of the present invention;

[0032] FIG. 7 is a schematic diagram of an assay system according to another embodiment of the present invention;

[0033] FIG. 8 is a graph illustrating ECL intensity results obtainable according to the present invention;

[0034] FIG. 9 is another graph illustrating ECL intensity results obtainable according to the present invention; and

[0035] FIG. 10 is a graph illustrating the improvement in ECL intensity results obtainable according to the present invention.

#### DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0036] In many diagnostic systems wherein binding reactions occur between reagents, improved mixing of the

reagents can increase the speed of the reaction. Often, the slow rate of mixing ultimately limits the speed with which a diagnostic test proceeds to completion. Examples of diagnostic assays wherein binding reactions between reagents occur include immunoassays, DNA-probe assays, clinical chemistry tests, receptor-ligand binding assays, and the like. The slow rate of binding kinetics has been an especially limiting constraint in conducting assays that incorporate binding reactions between reagents in solution and reagents present on a solid. Sonication improves the mixing of reagents in solution and the mass transport of reagents in solution to reagents located on or near a surface of a solid. Experiments have proven that sonication of assay reagents dramatically decreases the time required to conduct a binding assay that utilizes a solid-phase support. In the present application, sonication is defined to encompass vibration having a frequency between approximately 100 Hz and 10 MHz. The frequency of sonication ( $f_s$ ) can be sub-divided into the following ranges: low-frequency sonication ( $100 \text{ Hz} \leq f_s \leq 5 \text{ KHz}$ ), ultrasonication ( $5 \text{ KHz} \leq f_s \leq 1 \text{ MHz}$ ), and ultra-high sonication ( $1 \text{ MHz} \leq f_s$ ). The amplitude of the vibrations can be sub-divided into the following ranges: low amplitude sonication ( $<1 \mu\text{m}$ ), medium amplitude sonication ( $1\text{-}10 \mu\text{m}$ ) and high amplitude sonication ( $>10 \mu$ ).

[0037] The improved mixing achieved by the present invention finds ready and useful application in both end-point and kinetic assays. In an end-point assay, the concentration or amount of an analyte of interest is determined by measuring how much binding has occurred when the binding reaction has approached completion. We have found that sonication during the course of the binding reaction decreases the time required for the binding reaction to approach completion. In a kinetic assay, the concentration or amount of an analyte of interest is determined by measuring the rate of the binding reaction. Similarly, it has been found that sonication during the course of the binding reaction increases the rate of the binding reaction. The faster binding reaction produces measurable signals in much less time than previously possible. The present invention so greatly accelerates the rates of certain reactions that assays utilizing such reaction may be completed in only a matter of minutes, often in less than three minutes.

[0038] The rate of a mass transport-limited binding reaction on a solid support may be a function of both the concentration of the soluble reagent and the mass-transport coefficient for the mass-transfer of that reagent to the solid support. Therefore, it is especially important that the amount, rate, and type of sonication applied during a kinetic assay be carefully controlled and be precisely reproducible. Variations in the mass-transfer coefficients are likely to cause variations in reaction rate among otherwise identical tests and, consequently, render imprecise or entirely unusable results. The use of a sonication device structurally coupled to an assay cell and/or to a solid-phase support enables the conduct of kinetic binding assays that are quick, quantitative, highly sensitive, and reproducible.

[0039] It has been found that for sandwich immunoassays using capture antibodies located on a solid-phase support, the binding reaction can take more than  $\frac{1}{2}$  hour to reach completion, even when vortexing is used to increase mass transport to the solid-support surface. This time scale is typical of many highly sensitive solid-phase binding assays,