

[0055] FIG. 35 is a graph showing examined results of a relationship between the kind of the detection method and photocurrent in Example 2-3;

[0056] FIG. 36 is a graph showing examined results of a relationship between the concentration of the analyte (mouse IgG) and photocurrent in Example 2-4;

[0057] FIG. 37 is a graph showing examined results of a relationship between the concentration of the analyte (human IL-6) and photocurrent in the Example 2-5;

[0058] FIG. 38 is a graph showing examined results of a relationship between the kind of the detection subject and photocurrent in Example 2-6.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0059] The preferred embodiments of the present invention will be described hereinafter with reference to the drawings.

[Configuration of Detector]

[0060] An example of the detector to be used in the method for electrochemically detecting an analyte according to the first and second embodiments of the present invention will be explained with reference to the accompanying drawings.

[0061] Referring to FIG. 1, a detector 1 is used for the electrochemical detection method which uses a photochemically active substance as a labeling substance.

[0062] The detector 1 includes a chip insertion unit 11 into which a detection chip 20 is inserted and a display 12 which displays the detection results.

[0063] Referring to FIG. 2, the detector 1 includes a light source 13, an ammeter 14, a power source 15, an A/D converting unit 16, a control unit 17, and a display 12.

[0064] The light source 13 irradiates a labeling substance present on the working electrode of the detection chip 20 with light to excite the labeling substance. The light source 13 may be a light source which generates excitation light. Examples of the light source include fluorescent lamps, black light, bactericidal lamps, incandescent lamps, low-pressure mercury lamps, high-pressure mercury lamps, xenon lamps, mercury-xenon lamps, halogen lamps, metal halide lamps, light emitting diodes (white LED, blue LED, green LED, and red LED), lasers (carbon dioxide gas lasers, dye lasers, semiconductor lasers), and sunlight. Among the light sources, fluorescent lamps, incandescent lamps, xenon lamps, halogen lamps, metal halide lamps, LEDs, lasers or sunlight is preferred. Particularly, lasers are preferred. The light source may be configured such that only light in a specified wavelength region is emitted by a spectrometer or a bandpass filter, if necessary.

[0065] The ammeter 14 measures an electric current which flows through the detection chip 20 due to electrons released from the excited labeling substance.

[0066] The power source 15 applies a predetermined potential to an electrode formed in the detection chip 20.

[0067] The A/D converting unit 16 digitally converts the photocurrent values measured by the ammeter 14.

[0068] The control unit 17 is configured to include a CPU (Central Processing Unit), a ROM (Read Only Memory), and a RAM (Random Access Memory). The control unit 17 controls the operation of the display 12, the light source 13, the ammeter 14, and the power source 15. The control unit 17 estimates the amount of the labeling substance from the photocurrent value which has been digitally converted by the A/D

converting unit 16 based on a calibration curve indicating a relationship between a photocurrent value created in advance and the amount of the labeling substance and calculates the amount of the analyte.

[0069] The display 12 displays information such as the amount of the analyte which has been estimated by the control unit 17.

[0070] When the labeling substance is detected according to the oxidation reduction current/electrochemiluminescence detection method to be described later, the detector may not include the light source 13 (not shown).

[0071] When the labeling substance is detected by electrochemical luminescence, the detector may further include a sensor for detecting light generated from the labeling substance.

[Configuration of Detection Chip]

[0072] Next, the configuration of the detection chip 20 which is used for the method for electrochemically detecting an analyte according to the first and second embodiments of the present invention will be described.

[0073] Referring to FIG. 3 and FIGS. 4A to 4C, the detection chip 20 includes an upper substrate 30, a lower substrate 40 formed on the lower side of the upper substrate 30, and a spacing member 50 sandwiched between the upper substrate 30 and the lower substrate 40. In the detection chip 20, the upper substrate 30 and the lower substrate 40 are overlappedly arranged at one side portion. The spacing member 50 is intervened in a portion where the upper substrate 30 and the lower substrate 40 are overlapped.

[0074] The upper substrate 30 includes a substrate body 30a and a working electrode 60 as shown in FIG. 4B. A sample inlet 30b for injecting a sample containing an analyte into the inside is formed in the substrate body 30a. The working electrode 60 and an electrode lead 71 connected to the working electrode 60 are formed on the surface of the substrate body 30a. In the upper substrate 30, the working electrode 60 is disposed at one side portion [the left side of FIG. 4B] of the substrate body 30a. The electrode lead 71 is extended from the working electrode 60 to the other side portion of the substrate body 30a [the right side of FIG. 4B]. The sample inlet 30b is formed at an inner side than a portion where the spacing member 50 is interposed in the substrate body 30a.

[0075] The substrate body 30a is formed into a rectangular shape. The shape of the substrate body 30a is not particularly limited and it may be polygonal, discoid or the like. The shape of the substrate body 30a is preferably rectangular from the viewpoint of the production and easy handling of the substrate.

[0076] The material for forming the substrate body 30a is not particularly limited and examples thereof include glass; plastics such as polyethylene terephthalate and polyimide resin; and inorganic materials such as metal. Among them, glass is preferred from the viewpoint of ensuring light transmission properties, sufficient heat resistance, durability, and smoothness and reducing costs required for the materials. The thickness of the substrate body 30a is preferably from 0.01 to 1 mm, more preferably from 0.1 to 0.7 mm, still more preferably about 0.5 mm from the viewpoint of ensuring sufficient durability. The size of the substrate body 30a is not particularly limited, and it is usually about 20 mm×20 mm and it varies depending on the number of items on the premise of detection of various types of analytes (many items).