DEVICE AND METHOD FOR CHEMICAL ANALYSIS OF FLUIDS WITH A REAGENT COATED LIGHT SOURCE

BACKGROUND OF THE INVENTION

This invention relates to a method and a device for measuring light transmittance. More particularly, this invention relates to the qualitative or quantitative analysis of body fluids by measuring light transmitted from a coating, such as a reagent coated on the light emitting surface of a lamp. The invention is useful for detecting the presence of one or more constituents of a liquid test sample.

The spectral characteristics of light reflected and transmitted by a specimen are related to the chemical and physical characteristics of the specimen. With the advent of instrumental analysis, absorption of light by a specimen under test has become a widely used basis for biochemical assay procedures. For example, a reagent test strip used for qualitative and quantitative analysis can be contacted for a prescribed period of time with a body fluid, such as blood or urine. Light is projected onto the strip and light reflected by the strip is photoelectrically measured. The reflectance spectrum of the test strip will vary depending upon the concentration of the target substance in the body fluid being examined. Thus, by measuring the reflected light and computing the resulting reflectance, the desired analysis can be made by comparison with a standard based on a correlation of reflectance to concentration.

A reagent test strip is typically a test paper treated with various chemical reagents. Since the surface of the test strip does not have a uniform topography, it is difficult to make accurate and reproducible reflectance measurements because the result may depend upon where the measurement is made on the strip or on measurement geometry. In addition, some illumination from the light source is dissipated or lost. Thus, in order to obtain reflected energy of a desired magnitude, the magnitude of the illumination must be correspondingly increased to compensate for the light dissipated in the device. This can require a larger light source and the generation of heat in larger amounts and can lead to increased power consumption.

It has also been found with reagent test strips that the reflectance measurement is sensitive to the orientation of the strip in the test strip holder. For example, slight twisting or inclination of the specimen affects the magnitude of the reflectance measurement. In addition, it has been found that the reflectance measurement can be affected by the distance between the test strip and the light source.

Thus, there exists a need in the art for a method and a device for making rapid, accurate and reproducible optical measurements on a specimen under test. The device should employ direct illumination of the specimen. The device should minimize the amount of illumination dissipated or lost between the light source and the specimen in order to minimize power consumption. The device should provide optical measurements that are insensitive to subtle changes in the orientation of the specimen in the specimen holder and not susceptible to variations in the distance between the light source and the specimen.

SUMMARY OF THE INVENTION

Accordingly, this invention aids in fulfilling these needs in the art by providing a device for determining the presence or concentration of a substance in a medium by measuring light. The device comprises light source means for providing illumination and light responsive means for generating an electrical signal in response to light. Means are provided for measuring the electrical signal from the light responsive means. The light source has a surface through which or from which light passes. The surface has a coating thereon and the coating is chemically reactive with the substance being determined. Light from the light source passes through the surface and through or from the coating to the light responsive means. The amount of light transmitted through the coating after reaction with the substance being determined is a measure of the concentration of the substance in the coating. A light emitting diode (LED) is well suited for use as the light source.

This invention also provides a light-emitting diode having a light-emitting surface and a light-transmitting, liquid permeable coating on the surface. The coating contains a reagent composition for a ligand contained in a body fluid. Light from the diode illuminates the coating, and light transmitted from the coating changes after the ligand and reagent composition chemically react.

In addition, this invention provides a method for determining the presence or concentration of a ligand in a specimen by measuring transmission of light in a device comprising light source means for illuminating the specimen and means for measuring light from the specimen. The method comprises providing a transparent or translucent coating on a surface of the light source through which light from the light source passes. The coating contains a reagent that is chemically reactive with the ligand. Light from the light source transmitted from the coating to the measuring means is measured. A liquid containing the ligand is then applied onto the coating. The ligand and reagent are reacted for a time sufficient to react to form a reaction product. Light from the light source transmitted to the measuring means from the coating containing the reaction product is measured. The values obtained can then be compared with a standard.

It has been found that very accurate and reproducible optical measurements can be made on a specimen with this device and the procedure described. The measurement of light transmitted is not sensitive to slight changes in the orientation of the specimen in a specimen holder since the specimen is coated on the light source. In addition, the measurement is not susceptible to changes in the distance between the specimen and the light source as in prior art devices.

BRIEF DESCRIPTION OF THE DRAWINGS

This invention will be more fully understood by reference to the drawings in which:

FIG. **1** is a perspective view of a coated LED of the invention;

FIG. **2** is a perspective view of a device of the invention;

FIG. **3** is a plot of the ratio of photodetector measurements versus glucose concentration for experiments described in Example 1 using a translucent film coated on a LED;

FIG. **4** is a plot similar to FIG. **3**, except that all of the ratios calculated in Example 1 are plotted on a vertical