locations. This is due at least in part to expansive circuits and complex data processing that, combined with significant know-how, are required to obtain a desired result. Additionally, these devices typically require a large amount of power to operate.

[0007] These and other drawbacks of current systems exist.

SUMMARY ~~OF THE INVENTION~~

[0008] The ~~invention~~disclosure relates to devices and methods of measuring the concentration of an analyte. More particularly, the ~~invention~~disclosure relates to a sensor and a sensor interface module (SIM) that communicates with the sensor to measure the concentration of an analyte in a medium. The sensor and SIM may be used in various gaseous environments such as, for example, biochemical oxygen demand, inerting, combustion, environmental, chemical, diving/life support, and medical applications such as anesthesiology, respiration, and oxygen concentrators. The sensor and SIM may also be used in various submerged environments such as, for example, biochemical oxygen demand, implantable sensors, fish farming, aquariums, pollution monitoring, chemical processing, and brewing/fermentation. Each of these applications may be used to determine a concentration of various analytes such as, for example, oxygen, glucose, carbon dioxide, toxins or temperature, in a medium such as, for example, air, blood, water or other gaseous or liquid medium.

[0009] According to one embodiment, the ~~invention~~disclosure includes an optical sensor and a sensor interface module (SIM). The sensor includes a radiant source, photoelectric transducer, and indicator molecules. The sensor interface module includes a microcontroller that communicates with the sensor to drive the radiant source and receive data obtained by the sensor. The microcontroller causes the radiant source to irradiate the indicator molecules. The indicator molecules luminesce due to light emitted by the radiant source and exhibit certain characteristics based on an analyte present in the medium. The sensor transmits

data relating to this luminescence to the microcontroller for processing. Based on the data received, known data, and the Stern-Volmer relationship, the microcontroller determines a concentration of the analyte. According to one embodiment of the invention, the sensor interface module includes an interface that enables the module to transmit the data to an external data system so that the data may be presented to a system user.

[0009a] In one aspect, there is provided a device for measuring analyte concentration comprising: a sensor, said sensor comprising at least one indicator molecule in communication with a transducer; a sensor interface module in communication with the sensor, wherein the sensor interface module comprises a microcontroller; and wherein the sensor interface module is configured to perform time domain measurement of excitation emission of said at least one indicator molecule.

[0010] In a further~~one~~ aspect, there is~~the invention~~ provide~~s~~d a device for measuring an analyte concentration having a microcontroller configured to output a periodic digital signal of a predetermined frequency on a digital output bus of a microcontroller and compute a phase difference between a stimulus waveform and a response waveform present on analog inputs of the microcontroller.

[0011] The device also includes a digital-to-analog converter to convert the periodic digital signal to a periodic voltage waveform, a low pass filter to smooth the periodic voltage waveform and output the stimulus waveform, and a voltage-to-current converter operable to convert the stimulus waveform to a periodic current waveform and to drive a radiant source wherein the radiant source radiates onto indicator molecules.

[0012] The device further includes a bandpass transimpedance amplifier to convert a current from a photoelectric transducer to the response voltage waveform. Radiation from the indicator molecules is incident on the photoelectric transducer and the phase difference is a function of an analyte concentration local to the indicator molecules.

[0012a] In another aspect, there is provided a method of measuring a concentration of an analyte comprising: selecting a sensor; providing an indicator molecule adjacent the sensor; generating a stimulus waveform based on the analyte; exciting the indicator molecule; detecting a characteristic of the analyte based on its response characteristic to the indicator molecule excited; and determining the analyte concentration.

[0012b] In another aspect, there is provided a method of measuring a concentration of an analyte comprising: selecting a sensor; providing an indicator molecule adjacent the sensor; generating a stimulus waveform based on the analyte; exciting the indicator molecule; detecting a characteristic of the analyte based on its response characteristic to the indicator molecule excited; and determining the analyte concentration.

[0013] According to one embodiment ~~of the invention~~, a method is provided that measures a concentration of an analyte within a medium. The method uses a sensor that is provided with a plurality of indicator molecules. The indicator molecules exhibit a predetermined characteristic when in the presence of a particular analyte. The sensor generates a stimulus waveform that is used to drive an excitation source.

[0014] The indicator molecules are excited by the excitation source, based on a type of sensor used, to exhibit the characteristic associated with the analyte for which a concentration determination is desired. A response waveform for the characteristic exhibited is generated as a representation of the characteristic. The stimulus waveform and the response waveform are oversampled and a phase delay, which is dependent on the concentration of the analyte, is determined. The analyte concentration may then be determined using the phase delay determined and the Stern-Volmer relationship.

[0015] In a further aspect~~According to another embodiment of the invention~~, a method for determining the concentration of an analyte includes a step of creating a periodic digital output signal on a microcontroller output. The periodic digital output signal is converted into a smoothed driver current waveform, where the smoothed driver current waveform is of the same frequency as the periodic digital output signal.

[0016] The method also includes the steps of driving a radiant source with the smoothed driver current, where the radiation from the radiant source is incident on indicator molecules, detecting radiant excitation energy of the indicator molecules with a photoelectric transducer, where the photoelectric transducer outputs a waveform of the same frequency of the smoothed driver current waveform, and measuring a phase difference between the smoothed driver current waveform and the outputted photoelectric transducer waveform. The phase difference correlates to an analyte concentration local to the indicator molecules.

[0016a] In another aspect, there is provided a method of determining a presence of oxygen within a medium, comprising: selecting an oxygen sensor; providing the sensor with an indicator molecule; locating the sensor within a medium; transmitting a phase modulated signal to the sensor from a sensor interface module; determining a rate of change of the phase modulated signal; and determining a concentration of oxygen within the medium.

[0016b] In another aspect, there is provided a device for measuring analyte concentration comprising: an optical sensor including: at least one indicator molecule capable of excitation emission; a radiation source configured to radiate onto the at least one indicator molecule in accordance with a stimulus waveform; and a photoelectric transducer configured to detect radiation emitted by the at least one indicator molecule that is incident on the photoelectric transducer; and a sensor interface module configured to perform time domain measurement of the excitation emission of said at least one indicator molecule, the sensor interface module including: an amplifier operable to convert a current from the photoelectric transducer to a response waveform; a microcontroller configured to (i) generate a periodic digital output signal and (ii) compute a phase difference between the stimulus waveform and the response waveform, wherein the phase difference is a function of an analyte concentration local to the at least one indicator molecule; a digital-to-analog converter configured the periodic digital signal to a periodic voltage waveform; and a low pass filter configured to smooth the periodic voltage waveform and output the stimulus waveform.

[0017] The above and other features and advantages ~~of the invention~~, as well as the structure and operation of preferred embodiments of the ~~invention~~disclosure, are described in detail below with reference to the accompanying drawings.