5512490 : Optical sensor, optical sensing apparatus, and methods for detecting an analyte of interest using spectral recognition patterns

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ABSTRACT: The present invention is an optical detection and identification system and provides an optic sensor, an optic sensing apparatus and methodology for detecting and evaluating one or more analytes or ligands of interest, either alone or in admixture. The optic sensor of the system is comprised of a supporting member and an array formed of heterogeneous, semi-selective thin films which function as sensing receptor units and are able to detect a variety of different analytes and ligands using spectral recognition patterns.

U.S. REFERENCES: (No patents reference this one)

EXEMPLARY CLAIM(s): Show all 6 claims

What we claim is:
1. An optical sensor for detecting an analyte of interest in a fluid sample, said optical sensor comprising:
a supporting member; and
an optic array formed of multiple semi-selective sensing receptor units which differ in their constituent chemical formulations, which differ in their spectral characteristics, which are immobilized at different spatial positions on said supporting member for reactive contact with the fluid sample, and which react concurrently and semi-selectively but spectrally differently with an individual analyte of interest, each of said multiple semi-selective sensing receptor units of said optic array being comprised of
a polymeric substance of predetermined chemical composition, and
a semi-selective dye compound of predetermined chemical composition which has characteristic spectral properties, is disposed in admixture with said polymeric substance, and can react semi-selectively and spectrally differently over time with more than one analyte,
(a) wherein said admixed dye compound absorbs light energy of a predetermined wavelength and, in the presence of said polymeric substance without an analyte able to react semi-selectively, yields a baseline spectral response over time which is optically detectable and recognizable as showing an absence of analyte, and
(b) wherein said admixed dye compound absorbs light energy of a predetermined wavelength and, in the presence of said polymeric substance and at least one analyte of interest able to react semi-selectively, generates a modified spectral response over time which is optically detectable and recognizable as showing the spectral consequence of semi-selective reaction with the analyte of interest,
said multiple semi-selective sensing receptor units of said optic array presenting a plurality of differing and alternative modified spectral responses resulting in spectral recognition progression pattern means by which to detect and identify that analyte of interest.

RELATED U.S. APPLICATIONS: none
FOREIGN APPLICATION PRIORITY DATA: none
FOREIGN REFERENCES: none

OTHER REFERENCES:
6 CLAIMS

What we claim is:

1. An optical sensor for detecting an analyte of interest in a fluid sample, said optical sensor comprising:
   - a supporting member; and
   - an optic array formed of multiple semi-selective sensing receptor units which differ in their constituent chemical formulations, which differ in their spectral characteristics, which are immobilized at different spatial positions on said supporting member for reactive contact with the fluid sample, and which react concurrently and semi-selectively but spectrally differently with an individual analyte of interest, each of said multiple semi-selective sensing receptor units of said optic array being comprised of
     - a polymeric substance of predetermined chemical composition, and
     - a semi-selective dye compound of predetermined chemical composition which has characteristic spectral properties, is disposed in admixture with said polymeric substance, and can react semi-selectively and spectrally differently over time with more than one analyte.
   - (a) wherein said admixed dye compound absorbs light energy of a predetermined wavelength and, in the presence of said polymeric substance without an analyte able to react semi-selectively, yields a baseline spectral response over time which is optically detectable and recognizable as showing an absence of analyte, and
   - (b) wherein said admixed dye compound absorbs light energy of a predetermined wavelength and, in the presence of said polymeric substance and at least one analyte of interest able to react semi-selectively, generates a modified spectral response over time which is optically detectable and recognizable as showing the spectral consequence of semi-selective reaction with the analyte of interest,
   - (c) wherein said admixed dye compound absorbs light energy of a predetermined wavelength and, in the presence of said polymeric admixture with said polymeric substance, and can react semi-selectively and spectrally differently over time with more than one analyte,
   - (a) wherein said admixed dye compound absorbs light energy of a predetermined wavelength and, in the presence of said polymeric substance without an analyte able to react semi-selectively, yields a baseline spectral response which is optically detectable and recognizable as showing an absence of analyte, and
   - (b) wherein said admixed dye compound absorbs light energy of a predetermined wavelength and, in the presence of said polymeric substance and at least one analyte of interest able to react semi-selectively, generates a first modified spectral response over time which is optically detectable and recognizable as showing the spectral consequence of semi-selective reaction with the analyte of interest,
   - (c) wherein said admixed dye compound absorbs light energy of a predetermined wavelength and, in the presence of said polymeric substance and at least a second analyte of interest able to react semi-selectively, generates a second modified spectral response which is optically detectable and recognizable as showing the spectral consequence of semi-selective reaction with the second analyte of interest,
   - said multiple semi-selective sensing receptor units of said optic array presenting a plurality of differing and alternative modified spectral responses after semi-selective reaction with each of said first and second analytes of interest, the spectral pattern formed collectively by said plurality of differing and alternative modified spectral responses resulting in spectral recognition progression pattern means by which to detect and identify that analyte of interest.

2. An optical sensor for detecting a first analyte of interest which is intermixed with at least one other analyte of interest in a fluid sample, said optical sensor comprising:
   - a supporting member; and
   - an optic array formed of multiple semi-selective sensing receptor units which differ in their constituent chemical formulations, which differ in their spectral characteristics, which are immobilized at different spatial positions on said supporting member for reactive contact with the fluid sample, and which react concurrently and semi-selectively but spectrally differently with an individual analyte of interest, each of said multiple semi-selective sensing receptor units of said optic array being comprised of
     - a polymeric substance of predetermined chemical composition, and
     - a semi-selective dye compound of predetermined chemical composition which has characteristic spectral properties, is disposed in admixture with said polymeric substance, and can react semi-selectively and spectrally differently over time with more than one analyte.
   - (a) wherein said admixed dye compound absorbs light energy of a predetermined wavelength and, in the presence of said polymeric substance without an analyte able to react semi-selectively, yields a baseline spectral response over time which is optically detectable and recognizable as showing an absence of analyte, and
   - (b) wherein said admixed dye compound absorbs light energy of a predetermined wavelength and, in the presence of said polymeric substance and at least one analyte of interest able to react semi-selectively, generates a modified spectral response over time which is optically detectable and recognizable as showing the spectral consequence of semi-selective reaction with the analyte of interest,
   - (c) wherein said admixed dye compound absorbs light energy of a predetermined wavelength and, in the presence of said polymeric substance and a first analyte of interest able to react semi-selectively, generates a first modified spectral response over time which is optically detectable and recognizable as showing the spectral consequence of semi-selective reaction with the first analyte of interest,
   - said multiple semi-selective sensing receptor units of said optic array presenting a plurality of differing and alternative modified spectral responses after semi-selective reaction with each of said first and second analytes of interest, the spectral pattern formed collectively by said plurality of differing and alternative modified spectral responses for each of said first and second analytes of interest resulting in individual spectral recognition progression pattern means by which to detect and identify each of the analytes of interest in the fluid sample.

3. An optical sensing apparatus for detecting an analyte of interest in a fluid sample, said optical sensing apparatus comprising:
   - a supporting member; and
   - an optic array formed of multiple semi-selective sensing receptor units which differ in their constituent chemical formulations, which differ in their spectral characteristics, which are immobilized at different spatial positions on said supporting member for reactive contact with the fluid sample, and which react concurrently and semi-selectively but spectrally differently with an individual analyte of interest, each of said multiple semi-selective sensing receptor units of said optic array being comprised of
     - a polymeric substance of predetermined chemical composition, and
     - a semi-selective dye compound of predetermined chemical composition which has characteristic spectral properties, is disposed in admixture with said polymeric substance, and can react semi-selectively and spectrally differently with more than one analyte.
   - (a) wherein said admixed dye compound absorbs light energy of a predetermined wavelength and, in the presence of said polymeric substance without an analyte able to react semi-selectively, yields a baseline spectral response over time which is optically detectable and recognizable as showing an absence of analyte, and
   - (b) wherein said admixed dye compound absorbs light energy of a predetermined wavelength and, in the presence of said polymeric substance and at least one analyte of interest able to react semi-selectively, generates a modified spectral response over time which is optically detectable and recognizable as showing the spectral consequence of semi-selective reaction with the analyte of interest,
An optical method for detecting an analyte of interest in a fluid sample, said optical method comprising the steps of:

(a) providing an optical sensor comprising:

- a supporting member;
- an optic array formed of multiple semi-selective sensing receptor units which differ in their constituent chemical formulations, which differ in their spectral characteristics, which are immobilized at different spatial positions on said supporting member for reactive contact with the fluid sample, and which react concurrently and semi-selectively but spectrally differently with an individual analyte of interest, each of said multiple semi-selective sensing receptor units of said optic array being comprised of
  - a polymeric substance of predetermined chemical composition, and
  - a semi-selective dye compound of predetermined chemical composition which has characteristic spectral properties, is disposed in admixture with said polymeric substance, and can react semi-selectively and spectrally differently over time with more than one analyte,

(b) wherein said admixed dye compound absorbs light energy of a predetermined wavelength and, in the presence of said polymeric substance without an analyte able to react semi-selectively, yields a baseline spectral response over time which is optically detectable and recognizable as showing an absence of analyte, and

(c) wherein said admixed dye compound absorbs light energy of a predetermined wavelength and, in the presence of said polymeric substance and an analyte of interest able to react semi-selectively, generates a modified spectral response over time which is optically detectable and recognizable as showing the spectral consequence of semi-selective reaction with the analyte of interest, and

(d) wherein said admixed dye compound absorbs light energy of a predetermined wavelength and, in the presence of said polymeric substance and at least one analyte of interest able to react semi-selectively, generates a modified spectral response over time which is optically detectable and recognizable as showing the spectral consequence of semi-selective reaction with the analyte of interest,

said multiple semi-selective sensing receptor units of said optic array presenting a plurality of differing and alternative modified spectral responses after concurrent semi-selective reaction with each of the first and second analytes of interest, the spectral pattern formed collectively by said plurality of differing and alternative modified spectral responses for each of the first and second analytes of interest resulting in individual spectral recognition progression pattern means by which to detect and identify each of the analytes of interest in the fluid sample;

means for introducing a fluid sample to said optic array for semi-selective reactive contact;

means for introducing light energy of a predetermined wavelength to said multiple semi-selective sensing receptor units of said optic array; and

computerized optical detection and evaluation means for optically detecting said plurality of differing and alternative modified spectral responses generated by said semi-selective sensing receptor units and for evaluating said resulting spectral recognition progression pattern means to determine the presence of each of the analytes of interest in the fluid sample.

4. An optical sensing apparatus for detecting a first analyte of interest which is intermixed with at least one other analyte of interest in a fluid sample, said optical sensing apparatus comprising:

- a supporting member; and
- an optic array formed of multiple semi-selective sensing receptor units which differ in their constituent chemical formulations, which differ in their spectral characteristics, which are immobilized at different spatial positions on said supporting member for reactive contact with the fluid sample, and which react concurrently and semi-selectively but spectrally differently with an individual analyte of interest, each of said multiple semi-selective sensing receptor units of said optic array being comprised of

- a polymeric substance of predetermined chemical composition, and
- a semi-selective dye compound of predetermined chemical composition which has characteristic spectral properties, is disposed in admixture with said polymeric substance, and can react semi-selectively and spectrally differently over time with more than one analyte,

- (a) wherein said admixed dye compound absorbs light energy of a predetermined wavelength and, in the presence of said polymeric substance without an analyte able to react semi-selectively, yields a baseline spectral response over time which is optically detectable and recognizable as showing an absence of analyte, and

- (b) wherein said admixed dye compound absorbs light energy of a predetermined wavelength and, in the presence of said polymeric substance and a first analyte of interest able to react semi-selectively, generates a modified spectral response over time which is optically detectable and recognizable as showing the spectral consequence of semi-selective reaction with the analyte of interest, and

- (c) wherein said admixed dye compound absorbs light energy of a predetermined wavelength and, in the presence of said polymeric substance and at least a second analyte of interest able to react semi-selectively, generates a second modified spectral response over time which is optically detectable and recognizable as showing the spectral consequence of semi-selective reaction with the second analyte of interest,

said multiple semi-selective sensing receptor units of said optic array presenting a plurality of differing and alternative modified spectral responses after concurrent semi-selective reaction with each of the first and second analytes of interest, the spectral pattern formed collectively by said plurality of differing and alternative modified spectral responses for each of the first and second analytes of interest resulting in individual spectral recognition progression pattern means by which to detect and identify each of the analytes of interest in the fluid sample;

means for introducing a fluid sample to said optic array for semi-selective reactive contact;

means for introducing light energy of a predetermined wavelength to said multiple semi-selective sensing receptor units of said optic array; and

computerized optical detection and evaluation means for optically detecting said plurality of differing and alternative modified spectral responses generated by said semi-selective sensing receptor units and for evaluating said resulting spectral recognition progression pattern means to determine the presence of each of the analytes of interest in the fluid sample.

5. An optical method for detecting an analyte of interest in a fluid sample, said optical method comprising the steps of: providing an optical sensor comprised of:

- a supporting member; and
- an optic array formed of multiple semi-selective sensing receptor units which differ in their constituent chemical formulations, which differ in their spectral characteristics, which are immobilized at different spatial positions on said supporting member for reactive contact with the fluid sample, and which react concurrently and semi-selectively but spectrally differently with an individual analyte of interest, each of said multiple semi-selective sensing receptor units of said optic array being comprised of

- (a) a polymeric substance of predetermined chemical composition, and

- (b) a semi-selective dye compound of predetermined chemical composition which has characteristic spectral properties, is disposed in admixture with said polymeric substance, and can react semi-selectively and spectrally differently over time with more than one analyte,

- (i) wherein said admixed dye compound absorbs light energy of a predetermined wavelength and, in the presence of said polymeric substance without an analyte able to react semi-selectively, yields a baseline spectral response over time which is optically detectable and recognizable as showing an absence of analyte, and

- (ii) wherein said admixed dye compound absorbs light energy of predetermined wavelength and, in the presence of said polymeric substance and an analyte of interest able to react semi-selectively, generates a modified spectral response over time which is optically detectable and recognizable as showing the spectral consequence of semi-selective reaction with the analyte of interest,

said multiple semi-selective sensing receptor units of said optic array presenting a plurality of differing and alternative modified spectral responses after concurrent semi-selective reaction with the analyte of interest, the spectral pattern formed collectively by said plurality of differing and alternative modified spectral responses resulting in spectral recognition progression pattern means by which to detect and identify that analyte of interest;

introducing the fluid sample to said optical sensor for semi-selective reactive contact;

introducing light energy of a predetermined wavelength to said multiple semi-selective sensing receptor units of said optical sensor;

optically detecting said plurality of differing and alternative modified spectral responses generated over time by said semi-selective sensing receptor units of said optical sensor collectively to form said resulting spectral recognition progression pattern means; and

evaluating said resulting spectral recognition progression pattern means using computerized means to determine the presence of that analyte of interest in the fluid sample.
a support member; and
an optic array formed of multiple semi-selective sensing receptor units which differ in their constituent chemical formulations, which
differ in their spectral characteristics, which are immobilized at different spatial positions on said support member for reactive
contact with the fluid sample, and which react concurrently and semi-selectively but spectrally differently with an individual analyte
of interest, each of said multiple semi-selective sensing receptor units of said optic array being comprised of
(a) a polymeric substance of predetermined chemical composition, and
(b) a semi-selective dye compound of predetermined chemical composition which has characteristic spectral properties, is disposed
in admixture with said polymeric substance, and can react semi-selectively and spectrally differently over time with more than one
analyte,
   (i) wherein said admixed dye compound absorbs light energy of a predetermined wavelength and, in the presence of said
polymeric substance without an analyte able to react semi-selectively, yields a baseline spectral response over time which is
optically detectable and recognizable as showing an absence of analyte, and
   (ii) wherein said admixed dye compound absorbs light energy of a predetermined wavelength and, in the presence of said
polymeric substance and a first analyte of interest able to react semi-selectively, generates a first modified spectral response
over time which is optically detectable and recognizable as showing the spectral consequence of semi-selective reaction with
the first analyte of interest, and
   (iii) wherein said admixed dye compound absorbs light energy of a predetermined wavelength and, in the presence of said
polymeric substance and at least a second analyte of interest able to react semi-selectively, generates a second modified
spectral response over time which is optically detectable and recognizable as showing the spectral consequence of
semi-selective reaction with a second analyte of interest,
said multiple semi-selective sensing receptor units of said optic array presenting a plurality of differing and alternative modified
spectral responses after concurrent semi-selective reaction with each of the first and second analytes of interest, the spectral pattern
formed collectively by said plurality of differing and alternative modified spectral responses for each of the first and second analytes
of interest resulting in individual spectral recognition progression pattern means by which to detect and identify each of the analytes
of interest:
introducing the fluid sample to said optical sensor for semi-selective reactive contact;
introducing light energy of a predetermined wavelength to said multiple semi-selective sensing receptor units of said optical sensor;
optically detecting said plurality of differing and alternative modified spectral responses generated by said semi-selective sensing
receptor units of said optical sensor collectively to form individual resulting spectral recognition progression pattern means; and
evaluating said resulting spectral recognition progression pattern means individually using computerized means to determine the
presence of each of the analytes of interest in the fluid sample.