

into an instrument for operating the detection assay, for example, a detection device as disclosed in the present invention. The aptamers that specifically bind to a target allergen may be those disclosed in commonly owned U.S. Provisional Application Serial Nos.:

62/418,984, filed on November 8, 2016; and 62/435,106, filed on December 16, 2016;

5 62/512,299 filed on May 30, 2017; and the PCT application No. PCT/US2017/060487 filed on November 08 2017; the contents of each of which are incorporated herein by reference in their entirety.

[0006] The inventors of the present invention further developed detection systems which include a separate sampler, disposable cartridges/vessels and a detection instrument, for fast
10 and accurate detection of an allergen(s) in a sample using aptamer-based signal polynucleotides (SPNs). Particularly the aptamers and/or aptamer complement complexes are conjugated to magnetic beads and/or solid surfaces. The magnetic beads and solid surfaces coated with aptamer ligands are then used as detection sensors. The sensors may be integrated into the disposable cartridges of the present invention. They may also be used in
15 other detection systems. Such devices may be used by consumers in non-clinical settings, for example in the home, in restaurants and school cafeteria.

SUMMARY

[0007] The present disclosure provides systems, devices, disposable vessels/cartridges, optical modules and methods for use in allergen detection in various types of samples, in
20 particular, food samples. The allergen detection devices and systems are portable and handheld. In one example, the dimensions of the systems and devices may be less than 6 inches.

[0007a] In a first aspect, the present disclosure refers to a detection system for detecting the presence or absence of an allergen in a food sample, comprising (a) means for collecting a
25 food sample suspected of containing at least one allergen of interest; (b) a disposable detection cartridge configured for processing the food sample and contacting detection agents with said at least one allergen present in the food sample; and (c) a detection device configured for operating allergen detection, measuring and visualizing a signal from a binding interaction between the detection agents and the at least one allergen present in the
30 food sample, wherein the detection device comprises an optical system configured to measure absorbed light, scattered light, fluorescence or a combination thereof, which is a result of the

binding interaction between the detection agents and the at least one allergen.

[0007b] In a second aspect, the present disclosure refers to a method for calibrating an optical signal measuring system comprising (a) reading a baseline absorption signal of the system prior to any chemical reaction; (b) reading a first set of absorption, scatter and fluorescence signals after the addition of a reaction solution comprising magnetic particles, wherein the magnetic particles are coated with ligands labeled with one or more fluorophores; wherein the absorption signal indicates a signal decrease absorbed by the addition of the magnetic particles; the fluorescence signal represents the background auto-fluorescence signal from the reaction solution; and the scatter signal reflects the light signal scattered off the surface of the magnetic particles; (c) reading a second set of absorption, scatter and fluorescence signals after the addition of a test sample and the chemical reaction between the ligands and the test sample, wherein the second absorption signal indicates the presence of the magnetic particles; the second fluorescence signal indicates the gross fluorescence signal from the chemical reaction with the test sample; and the second scatter signal indicates the light signal scattered off the surface of the mixture of magnetic particles and the test sample; and (d) comparing signals read from steps (a), (b) and (c) to calibrate the optic signal measuring system.

[0007c] In a third aspect, the present disclosure refers to a method for measuring a signal to detect an allergen of interest in a test sample, comprising (a) reading a baseline absorption band signal of the system prior to any chemical reaction; (b) reading a first set of absorption, scatter and fluorescence signals after the addition of a reaction solution comprising magnetic beads, wherein the magnetic beads are coated with ligands which are labeled with one or more fluorophores; wherein the absorption signal indicates a signal decrease absorbed by the addition of the magnetic particles; the fluorescence signal represents the background auto-fluorescence signal from the reaction solution; and the scatter signal reflects the light signal scattered off the surface of the magnetic particles; (c) reading a second set of absorption, scatter and fluorescence signals after the addition of a test sample and the chemical reaction between the ligands and the test sample, wherein the second absorption signal indicates the presence of the magnetic particles; the second fluorescence signal indicates the gross fluorescence signal from the chemical reaction with test sample; and the second scatter signal indicates the light signal scattered off the surface of the mixture of magnetic particles and the test sample; (d) washing out the unbound compounds from the chemical reaction mixture, wherein the magnetic particles are held by the presence of a magnetic force; (e) reading a third set of absorption, scatter and fluorescence signals after washing; wherein the third

absorption signal indicates the presence of the magnetic particles; the third fluorescence signal represents signal from the complexes of the ligand and the allergen of interest; and the third scatter signal reflects the light signal scattered off the surface of the magnetic particles; and (f) measuring the presence, absence, and /or quantity of the allergen of interest in the test sample.

[0007d] In a fourth aspect, the present disclosure refers to a method for detecting the presence or absence of an allergen in a food sample comprising (a) collecting a food sample and processing the food sample, wherein the food sample is homogenized and proteins from the food sample are extracted in an extraction buffer; (b) transferring the processed sample into an optic detection chamber within a disposable cup, wherein the optic detection chamber is preloaded with detection agents, wherein the detection agents comprise magnetic beads coated with aptamers which are labeled with one or more fluorophores; (c) mixing the processed sample with the magnetic beads; (d) reading a first set of absorption, scatter and fluorescence signals; (e) washing out the unbound compounds from the mixture; (f) reading a second set of absorption, scatter and fluorescence signals; (g) comparing the first and second sets of absorption, scatter and fluorescence signals of steps (d) and (f) and to the absorption, scatter and fluorescence signals read prior to the transfer of the test sample to the optic detection chamber; and (h) detecting the presence or absence of the allergen in the food sample.

[0007e] In a fifth aspect, the present disclosure refers to a method for detecting the presence or absence of an allergen in a food sample comprising (a) collecting a food sample and processing the food sample, wherein the food sample is homogenized and proteins from the food sample are extracted in an extraction buffer; (b) transferring the processed sample into an optical detection chamber within a disposable cup, wherein the optical detection chamber comprises a glass chip which has a surface coated with aptamers labeled with one or more fluorophores; (c) mixing the processed sample with the aptamers immobilized on the glass chip; (d) reading fluorescence signals from a test area and two control areas of the glass chip; (e) washing out the unbound compounds from the mixture; (f) reading a second set of fluorescence signals from the test area and two control areas of the glass chip; (g) comparing the fluorescence signals of steps (d) and (f) and to fluorescence signals read prior to the transfer of the test sample to the optic detection chamber; and (h) detecting the presence or absence of the allergen in the food sample.

[0007f] In a sixth aspect, the present disclosure refers to a system for detecting the presence of an allergen in a sample, the system comprising: (a) a device comprising: an optical system configured to measure absorbed light, scattered light, fluorescence or a combination thereof, as a result of binding of a detection agent to the allergen; b) a test cartridge configured to dock into a receptacle of the device, the test cartridge comprising (i) a homogenization chamber including a rotor for homogenizing the sample and extracting allergens; (ii) a wash buffer chamber; (iii) a waste chamber configured to receive waste; and (iv) a reaction and optical detection chamber in optical communication with the optical system, for detecting the binding of the detection agent to the allergen.

[0007g] In a seventh aspect, the present disclosure refers to a kit comprising one or more disposable cartridges as recited in the sixth aspect for use with the device as recited in the sixth aspect, the kit further comprising instructions for placement of the disposable cartridges into the receptacle of the device.

[0007h] In an eighth aspect, the present disclosure refers to an optical system for detecting a signal comprising: (a) an optical detection chamber having a detector; (b) excitation optics comprising: (i) a light source having a spectral range, the light source configured to transmit an excitation light to an optical detection chamber; (ii) at least one excitation filter configured to allow specific wavelengths of excitation light to pass to the optical detection chamber, wherein the wavelengths may include: an absorption band for determining the presence of detection agents in the optical detection chamber, the detection agents may be magnetic particles coated with ligands that bind to an allergen of interest; a scatter band for detecting light scattered of the surface of a test sample inside the optical detection chamber; and a fluorescent band configured to detect a fluorescence signal derived from an interaction between the ligands and the allergen of interest; and wherein the excitation optics may further comprise optics capable of confining a light path; (c) emission optics capable of collecting fluorescence emissions from the test sample, the emissions optics comprising at least one emission filter configured to allow primarily light with wavelengths in the emission band to reach the detector; and wherein the emission optics may further comprise optics capable of confining a light path; (d) scatter optics capable of measuring scattering light signals; and (e) absorption optics capable of measuring the light absorbance prior to an optical reading.

[0008] One example of the present disclosure is directed to an allergen detection system for detecting the presence and/or absence of one or more allergens in a food sample. In various embodiments, the system comprises: (a) means for collecting a test sample; (b) at least one

disposable detection vessel/cartridge (as used herein, the terms “vessel” and ‘cartridge” and “test cup” are used interchangeably) for receiving and processing the test sample, and analyzing the interaction between an allergen(s) in the test sample and the detection agents; and (c) a detection device for reading detection signals and detecting the allergen(s) in the

5 test sample. The detection device may be removably connected to the disposable cartridge. In some examples, the assay further comprises a step of washing and re-suspending the magnetic beads when they are used as the sensors for detecting the target allergen.

[0009] In some examples, a separate sampler may provide means for collecting a test sample. In one example, the sampler is a separate food corer for collecting a food sample. The food corer may be configured for measuring a sized portion of a food sample and/or pre-processing the collected food sample. The food corer may have a distal portion provided with

5 a corer top cap at the distal end and a proximal portion provided with a cutting edge at the distal end which is configured to pick a food sample and pre-process the picked sample.

[0010] In one example, the food corer comprises a plunger having a distal end connecting to the corer top cap and a proximal plunger tip with a seal, a handle and a corer configured for holding the test sample being picked.

10 **[0011]** In some examples, the detection cartridge is disposable, suitable for one particular allergen. The detection cartridge comprises at least one homogenization chamber and at least one detection/reaction chamber where the detection reaction occurs. In one example of the disclosure, the detection cartridge may be a disposable test cup or cup-like container. The disposable test cup or cup-like container may be constructed as an analytical module in which

15 a test sample is processed and an allergen of interest in the test sample is detected through the interaction with detection agents. In some examples, the disposable test cup or cup-like container comprises a cup body, a cup bottom and a cup lid. The test cup may be divided into several compartments specialized for various functions, including homogenization, buffer storage, waste collection, allergen reaction and signal detection.

20 **[0012]** In some examples, the reaction and signal detection chamber may comprise a specialized area which is configured for holding a detection sensor specific for a target allergen. In some examples, the detection sensor may be magnetic beads conjugated with aptamers that bind to the target allergen. The aptamers or their complements may be attached to the magnetic beads directly or through any other anchors and linkers. In other examples,

25 the detection sensor may be a solid support of which the surface is coated with aptamers that bind to the target allergen. In one example, the specialized sensing area within the reaction and signal detection chamber may be a fluidic chip comprising a flow cell; the flow cell is configured for holding magnetic beads. The reaction and signal detection chamber may comprise at least one optical window. In one example, the chamber comprises two optical

30 windows, one primary optical window configured for reading optical signals and one secondary optical window configured

for reading light absorption or reading both light absorption and scattered light. In other examples, the chamber may comprise a separate window configured for reading scattered light.

[0013] In an example, the detection device of the present disclosure comprises (a) an external housing that provides support for the components of the detection device; (b) a mate plane or receptacle for coupling a detection cartridge (e.g., a disposable test cup or cup-like container) when implementing an allergen detection testing; and (c) means integrated for operating an allergen detection testing; and an optional plug for power supply.

[0014] In accordance with the present disclosure, the components of the detection device that are integrated for operating an allergen detection testing include (i) means for processing a test sample comprising a homogenizer; (ii) means for driving and controlling the homogenization; (iii) means for driving and controlling the flow of the processed sample during the process of an allergen detection testing; (iv) an optical system for detecting a reaction signal; and (v) means for visualizing a detection result including means of converting and digitizing the detection signal and a display window; and (vi) a power supply.

[0015] In some examples, means for driving the liquid flow and controlling the flow rate may be a pump or an external pressure. The pump may be a gas or air pump, or an equivalent thereof. The processed sample solution is flowed into a plurality of chambers within the detection cartridge (e.g., the test cup or cup-like container) during a detection assay.

[0016] In some examples, the optical system may comprise excitation optics, emission optics, scatter optics and absorption optics.

[0017] In some examples, a printed circuit board (PCB) is connected directly or indirectly to the optical system for displaying the testing readout. The result may be displayed as numbers, icons, colors and/or letters, or other equivalents.

[0018] Another example of the present disclosure relates to an allergen detection testing assay for detection of the allergen content in a sample comprising the steps of (a) obtaining a test sample suspected of containing an allergen(s) of interest, (b) homogenizing the obtained sample and extracting allergen proteins using an extraction buffer, (c) contacting the processed sample with a detection sensor which comprises magnetic beads or solid surfaces coated with aptamers and/or aptamer-complement complexes that specifically bind to a target allergen; (d) determining a fluorescence signal arising from the contacting step in (c); and (e) processing and digitizing the detected signals and visualizing the interaction between the

detection agents and the allergen(s).

[0019] In some examples, the detection system may comprise a user interface that may be accessed and controlled by a software application. The software may be run by a software

application on a personal device such as a smartphone, a tablet computer, a personal computer, a laptop computer, a smartwatch and/or other devices. In some examples, the software may be run by an internet browser. In some examples, the software may be connected to a remote and localized server referred to as the cloud.

5 **BRIEF DESCRIPTION OF THE DRAWINGS**

[0020] FIG. 1 is an embodiment of a detection system in accordance with the present invention comprising a detection device **100** having an external housing **101** and a mate plane or receptacle **102** configured for holding the disposable test cup **300**, a separate food corer **200** as an example of the sampler, a disposable test cup **300** as an example of the detection
10 cartridge. Optionally, an execution/action button **104** that allows a user to execute an allergen detection testing and a display window **103** may be included.

[0021] FIG. 2 illustrates an assembly of the detection system shown in FIG. 1 during the process of implementing an allergen detection testing.

[0022] FIG. 3A illustrates an embodiment of the food corer **200** as an example of the
15 sampler.

[0023] FIG. 3B illustrates a sampler assembly **200**.

[0024] FIGs. 4A to 4F illustrate exemplary embodiments of the cutting edge **331**.

[0025] FIG. 5A illustrates an embodiment of a disposable test cup **300** in a side view, comprising a cup top cover **510**, a cup body **520**, a cup bottom **530** and a rotor **540**.

20 [0026] FIG. 5B is a section view of the test cup **300**, demonstrating one embodiment of the configurations inside the cup body **520**: the homogenization chamber **521**, wash buffer storage chamber **522**, waste chamber **523**, and reaction and signal detection chamber **524** having a primary optical window **525** and a secondary optical window **526**.

25 [0027] FIG. 6A and FIG. 6B illustrate exploded views of two different embodiments of the disposable test cup **300**.

[0028] FIG. 7 is a perspective view of the bottom of the test cup **300**.

[0029] FIG. 8 illustrates the upper surface of the cup bottom **530**, showing the flow channel **812**, reaction and detection chamber **524** and air port **813**.

[0030] FIG. 9 indicates the positions of the fluid storage reservoirs within the test cup **300**.

30 [0031] FIG. 10A illustrates a pinch valve prior to a pin **1004** breaking the foil seal **1002**.

[0032] FIG. 10B illustrates the same pinch valve of FIG. 10A in the closed state, sealed by a gasket **1003** pushed upward by the pin **1004**.

CLAIMS

1. A detection system for detecting the presence or absence of an allergen in a food sample, comprising

(a) means for collecting a food sample suspected of containing at least one allergen of interest;

(b) a disposable detection cartridge configured for processing the food sample and contacting detection agents with said at least one allergen present in the food sample; and

(c) a detection device configured for operating allergen detection, measuring and visualizing a signal from a binding interaction between the detection agents and the at least one allergen present in the food sample, wherein the detection device comprises an optical system configured to measure absorbed light, scattered light, fluorescence or a combination thereof, which is a result of the binding interaction between the detection agents and the at least one allergen.

2. The detection system of claim 1, wherein the detection system further comprises

(a) a food corer for collecting the food sample;

(b) at least one disposable test cup comprising a port for inserting the food corer; and wherein the detection device further comprises a mate plane for docking the at least one test cup.

3. The detection system of claim 2, wherein the food corer, extending between a distal end and a proximal end, comprises a plunger, a skirt and a corer, wherein the proximal end of the corer includes a cutting edge for cutting the test sample.

4. The detection system of claim 3, wherein the plunger of the food corer comprises a seal at the proximal end.

5. The detection system of any one of claims 3-4, wherein the cutting edge is a blade, a flat edge, a sharp edge, a serrated edge with various numbers of teeth, a sharp serrated edge, or a thin wall edge.

6. The detection system of claim 2, wherein the disposable test cup comprises

- (i) a cup top cover;
- (ii) a cup body;
- (iii) a cup bottom assembly; and
- (iv) a homogenization rotor;

5 wherein the cup bottom assembly provides interfaces for connecting to the mate plane of the detection device.

7. The detection system of claim 6, wherein the cup body comprises a plurality of chambers, connected to one another, so that a fluid can flow between chambers, wherein the cup body
10 comprises:

- (1) a homogenization chamber, in which the test sample can be homogenized and proteins can be extracted from the at least one allergen;
- (2) a washing chamber, in which a processed sample solution and/or a mixture of the test sample and detection agents can be washed;
- 15 (3) a waste chamber configured for holding waste from the detection system or a detection assay; and
- (4) a reaction and optical detection chamber, in which reaction signals and reference signals can be read.

20 8. The detection system of claim 7, wherein the reaction and optical detection chamber further comprises:

magnetic beads conjugated with nucleic acid molecules that bind to at least one allergen, or

a solid support of which the surface is coated with nucleic acid molecules that bind to
25 the at least one allergen.

9. The detection system of claim 8, wherein the nucleic acid molecules are aptamers or aptamer-complement complexes which bind to the at least one allergen with high specificity and affinity.

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10. The detection system of any of claims 8 and 9, wherein the magnetic beads are polystyrene beads comprising magnetite.

11. The detection system of claim 9, wherein the magnetic beads are lyophilized or in aqueous solution.
12. The detection system of claim 8, wherein the solid support is selected from a group consisting of a glass chip, silica, agarose beads, acrylic glass, a microwell and a microchip.
13. The detection system of claim 8, wherein the reaction and optical detection chamber further comprises a first optical window and a secondary optical window, wherein the first and secondary optical windows are aligned with the optical system of the detection device when the test cup is inserted into the detection device.
14. The detection system of claim 6, wherein the homogenization rotor can be inserted into the test cup body through a rotor interface at the cup bottom assembly.
15. The detection system of claim 6, wherein the homogenization rotor can be inserted into the test cup body through a rotor port at the cup top cover.
16. The detection system of claim 6, wherein the test cup further comprises a filter.
17. The detection system of claim 16, wherein the filter is attached to the cup top cover, and wherein the filter is a filter membrane or a filter assembly.
18. The detection system of claim 2, wherein the detection device comprises
- (a) an external housing configured for providing support for the components of the detection device;
 - (b) components integrated for operating an allergen detection testing; and
 - (c) a power supply;
- wherein the components integrated for operating the detection testing comprise
- (i) means for driving and controlling the homogenization;
 - (ii) means for driving and controlling the flow of the processed sample solution during the process of the allergen detection testing;
 - (iii) means for collecting and retaining magnetic beads;
 - (iv) means for re-suspending magnetic beads;

- (v) means for converting and digitizing the fluorescence signals; and
- (vi) a display window for receiving the detected signals and indicating the presence and/or absence of the allergen in the test sample.

5 19. The detection system of claim 18, wherein the components of the detection device for operating the detection testing further comprise:

- (a) a motor coupled to the homogenization rotor;
- (b) a pump;
- (c) at least one magnetic collection actuator;
- 10 (d) a vibratory re-suspension actuator;
- (e) a signal processor; and
- (f) a display interface.

20. The detection system of claim 19, wherein the optical system comprises:

- 15 (a) a light source having a light spectral range configured to transmit an excitation light to an optical detection chamber;
- (b) one or more excitation filters configured to select specific excitation wavelengths of light from the light source, wherein at least three different light wavelength bands can be selected:
- 20 one absorption band for determining the presence of detection agents in the optical detection chamber, wherein the detection agents are magnetic particles coated with signal polynucleotides (SPNs),
- one scatter band for detecting light scattered off the food sample inside the optical detection chamber, and
- 25 one fluorescence band configured to detect a fluorescence signal derived from the interaction of the allergen of interest and SPNs; and
- (c) optional optics capable of confining the light path.

21. The detection system of claim 19 and claim 20, wherein the optical system comprises:

- 30 (a) one or more emission filters operable to allow substantially light with wavelengths in an emission band to reach the detector;
- (b) optics configured to collect and confine emitted light; and

wherein the detection device further comprises a detector capable of measuring signals.

22. The detection system of claim 19, wherein the magnetic bead collection actuator further comprises:

(a) a magnetic field generator which generates a magnetic field to hold and separate magnetic beads, and

(b) an actuator;

wherein the magnet field generator comprises a permanent magnet, or electromagnet.

23. A method for calibrating an optical signal measuring system comprising

(a) reading a baseline absorption signal of the system prior to any chemical reaction;

(b) reading a first set of absorption, scatter and fluorescence signals after the addition of a reaction solution comprising magnetic particles, wherein the magnetic particles are coated with ligands labeled with one or more fluorophores;

wherein the absorption signal indicates a signal decrease absorbed by the addition of the magnetic particles; the fluorescence signal represents the background auto-fluorescence signal from the reaction solution; and the scatter signal reflects the light signal scattered off the surface of the magnetic particles;

(c) reading a second set of absorption, scatter and fluorescence signals after the addition of a test sample and the chemical reaction between the ligands and the test sample, wherein the second absorption signal indicates the presence of the magnetic particles; the second fluorescence signal indicates the gross fluorescence signal from the chemical reaction with the test sample; and the second scatter signal indicates the light signal scattered off the surface of the mixture of magnetic particles and the test sample; and

(d) comparing signals read from steps (a), (b) and (c) to calibrate the optic signal measuring system.

24. A method for measuring a signal to detect an allergen of interest in a test sample, comprising

(a) reading a baseline absorption band signal of the system prior to any chemical reaction;

(b) reading a first set of absorption, scatter and fluorescence signals after the addition of a reaction solution comprising magnetic beads, wherein the magnetic beads are coated with ligands which are labeled with one or more fluorophores;

wherein the absorption signal indicates a signal decrease absorbed by the addition of the magnetic particles; the fluorescence signal represents the background auto- fluorescence signal from the reaction solution; and the scatter signal reflects the light signal scattered off the surface of the magnetic particles;

(c) reading a second set of absorption, scatter and fluorescence signals after the addition of a test sample and the chemical reaction between the ligands and the test sample, wherein the second absorption signal indicates the presence of the magnetic particles; the second fluorescence signal indicates the gross fluorescence signal from the chemical reaction with test sample; and the second scatter signal indicates the light signal scattered off the surface of the mixture of magnetic particles and the test sample;

(d) washing out the unbound compounds from the chemical reaction mixture, wherein the magnetic particles are held by the presence of a magnetic force;

(e) reading a third set of absorption, scatter and fluorescence signals after washing; wherein the third absorption signal indicates the presence of the magnetic particles; the third fluorescence signal represents signal from the complexes of the ligand and the allergen of interest; and the third scatter signal reflects the light signal scattered off the surface of the magnetic particles; and

(f) measuring the presence, absence, and /or quantity of the allergen of interest in the test sample.

25. A method for detecting the presence or absence of an allergen in a food sample

comprising

(a) collecting a food sample and processing the food sample, wherein the food sample is homogenized and proteins from the food sample are extracted in an extraction buffer;

(b) transferring the processed sample into an optic detection chamber within a disposable cup, wherein the optic detection chamber is preloaded with detection agents, wherein the detection agents comprise magnetic beads coated with aptamers which are labeled with one or more fluorophores;

(c) mixing the processed sample with the magnetic beads;

(d) reading a first set of absorption, scatter and fluorescence signals;

- (e) washing out the unbound compounds from the mixture;
- (f) reading a second set of absorption, scatter and fluorescence signals;
- (g) comparing the first and second sets of absorption, scatter and fluorescence signals of steps (d) and (f) and to the absorption, scatter and fluorescence signals read prior to the transfer of the test sample to the optic detection chamber; and
- (h) detecting the presence or absence of the allergen in the food sample.

26. The method of claim 25 further comprising reading a baseline absorption band signal of the system prior to any chemical reaction, wherein the absorption reading is used as a reference signal for calculating the optical signals upon the interaction between the detection agent and the allergen.

27. A method for detecting the presence or absence of an allergen in a food sample comprising

- (a) collecting a food sample and processing the food sample, wherein the food sample is homogenized and proteins from the food sample are extracted in an extraction buffer;
- (b) transferring the processed sample into an optical detection chamber within a disposable cup, wherein the optical detection chamber comprises a glass chip which has a surface coated with aptamers labeled with one or more fluorophores;
- (c) mixing the processed sample with the aptamers immobilized on the glass chip;
- (d) reading fluorescence signals from a test area and two control areas of the glass chip;
- (e) washing out the unbound compounds from the mixture;
- (f) reading a second set of fluorescence signals from the test area and two control areas of the glass chip;
- (g) comparing the fluorescence signals of steps (d) and (f) and to fluorescence signals read prior to the transfer of the test sample to the optic detection chamber; and
- (h) detecting the presence or absence of the allergen in the food sample.

28. The method of claim 27, wherein the fluorescence signals read in step (g) comprise signals from the test area and the two control areas of the glass chip.

29. A system for detecting the presence of an allergen in a sample, the system comprising:

(a) a device comprising: an optical system configured to measure absorbed light, scattered light, fluorescence or a combination thereof, as a result of binding of a detection agent to the allergen;

b) a test cartridge configured to dock into a receptacle of the device, the test cartridge comprising

(i) a homogenization chamber including a rotor for homogenizing the sample and extracting allergens;

(ii) a wash buffer chamber;

(iii) a waste chamber configured to receive waste; and

(iv) a reaction and optical detection chamber in optical communication with the optical system, for detecting the binding of the detection agent to the allergen.

30. The system of claim 29, wherein the reaction and optical detection chamber further comprises magnetic beads conjugated with nucleic acid molecules that bind to the allergen, or a solid support having a surface coated with nucleic acid molecules that bind to the allergen.

31. The system of claim 30, wherein the nucleic acid molecules are aptamers or aptamer-complement complexes which bind to the allergen with high specificity and affinity.

32. The system of claim 30, wherein the magnetic beads are polystyrene beads comprising magnetite.

33. The system of claim 30, wherein the magnetic beads are lyophilized or in aqueous solution.

34. The system of claim 30, wherein the solid support is selected from the group consisting of: a glass chip, silica, agarose beads, acrylic glass, a microwell, and a microchip.

35. The system of claim 29, wherein the reaction and optical detection chamber further comprises a first optical window and a secondary optical window, wherein the first and secondary window are aligned with the optical system of the detection device when the test cartridge is inserted into the receptacle of the device.

36. The system of claim 29, wherein the rotor connects to a rotor-driving motor at an interface on the bottom of the cartridge.

5 37. The system of claim 29, wherein the homogenization chamber may include extraction buffer and the wash buffer chamber may include wash buffer.

10 38. The system of claim 37, wherein the homogenization chamber and the wash buffer chamber each have passages with lower openings having seals which, when broken, permit fluid flow into a lower flow channel for transfer of homogenized sample and wash buffer to the reaction and optical detection chamber.

39. The system of claim 38, wherein the device includes upwardly extending pins for breaking the seals when the cartridge is inserted into the receptacle.

15 40. The system of claim 39, wherein the seals are foil seals.

41. The system of claim 39, wherein the pins cooperate with an upper gasket to form a pinch valve to open and close the passages.

20 42. The system of claim 30, wherein the device comprises a magnet movable between a first position for attracting the magnetic beads to an interior wall of the reaction and optical detection chamber and a second position for allowing dispersal of the magnetic beads throughout the interior of the reaction and optical detection chamber.

25 43. The system of claim 29, wherein the optical system is configured to measure absorbed light, scattered light and fluorescence with a single detector, wherein the absorbed light indicates the presence of magnetic beads and/or sample in the reaction and optical detection chamber, the scattered light indicates the presence of sample in the chamber, and the fluorescence indicates detection of the allergen.

30 44. The system of claim 43, wherein the cartridge comprises a first optical window configured for reading optical signals and a second optical window configured for reading light absorption or reading both light absorption and scattered light.

45. The system of claim 38, wherein the lower flow channel comprises an air port for communication of the lower flow channel with atmospheric pressure via a gas permeable membrane.

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46. The system of claim 38, further comprising at least one valve at the entrance and exit of the reaction and optical detection chamber, wherein the entrance is at the end of the lower flow channel and the exit leads to the waste chamber.

10 47. The system of claim 29, wherein a drive mechanism for the rotor is located in the device below the receptacle.

48. The system of claim 29, wherein the cartridge includes an upper opening configured for insertion of a sampling device for addition of a sample to the homogenization chamber.

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49. The system of claim 29, further comprising a sampling device configured for insertion in an upper opening of the cartridge, for addition of a sample to the homogenization chamber.

20 50. The system of claim 48, wherein the sampling device includes an upper plunger for pushing the sample into the homogenization chamber.

51. The system of claim 48, wherein the sampling device is a food corer.

25 52. The system of claim 48, wherein a proximal end of the food corer includes a cutting edge for cutting the sample.

53. The system of claim 30, wherein the device further comprises a magnetic bead resuspension actuator in the receptacle, the resuspension actuator configured for contacting the cartridge to effect resuspension of the magnetic beads.

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54. The system of claim 53, wherein the magnetic bead resuspension actuator is a vibratory actuator.

55. The system of claim 54, wherein the vibratory actuator is an ultrasonic wave generator or a low frequency vibrator.

56. The system of claim 30, wherein the magnetic beads are conjugated to a signaling polynucleotide.

57. The system of claim 29, wherein the reaction and optical detection chamber comprises a glass chip with a signaling polynucleotide conjugated thereto.

58. A kit comprising one or more disposable cartridges as recited in claim 29 for use with the device as recited in claim 29, the kit further comprising instructions for placement of the disposable cartridges into the receptacle of the device.

59. An optical system for detecting a signal comprising:

(a) an optical detection chamber having a detector;

(b) excitation optics comprising:

(i) a light source having a spectral range, the light source configured to transmit an excitation light to an optical detection chamber

(ii) at least one excitation filter configured to allow specific wavelengths of excitation light to pass to the optical detection chamber, wherein the wavelengths may include: an absorption band for determining the presence of detection agents in the optical detection chamber, the detection agents may be magnetic particles coated with ligands that bind to an allergen of interest; a scatter band for detecting light scattered off the surface of a test sample inside the optical detection chamber; and a fluorescent band configured to detect a fluorescence signal derived from an interaction between the ligands and the allergen of interest; and

wherein the excitation optics may further comprise optics capable of confining a light path;

(c) emission optics capable of collecting fluorescence emissions from the test sample, the emissions optics comprising at least one emission filter configured to allow primarily light with wavelengths in the emission band to reach the detector; and

wherein the emission optics may further comprise optics capable of confining a light path;

(d) scatter optics capable of measuring scattering light signals; and
(e) absorption optics capable of measuring the light absorbance prior to an optical reading.

5 60. The optical system of claim 59, wherein the at least one excitation filter is a band-pass filter, which may limit light source to a range of wavelengths.

61. The optical system of claim 60, wherein the optics capable of confining a light path may be a focus lens, a dichroic beamsplitter, or a dichromatic mirror.

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62. The optical system of claim 61, wherein the detector may be photodiodes, complementary metal-oxide-semiconductor (CMOS) detector, photomultiplier tubes (PMT), microchannel plate detector, quantum dot photoconductor, phototransistor, photoresistor, active-pixel sensor (APS), gaseous ionization detector, or charge-coupled device (CCD) detector.

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