Systems and Methods for Biological Analysis

Background of the Invention

Field of the Invention

[0001] The present invention relates generally to systems, devices, and methods for observing, testing, and/or analyzing one or more biological samples, and more specifically to systems, devices, and methods for observing, testing, and/or analyzing an array of biological samples.

Description of the Related Art

[0002] Generally, there is an increasing need to automate biological analysis systems to increase efficiency. For example, advances in automated biological sample processing instruments allow for quicker, more efficient, and high throughput analysis of samples. These types of systems may assay a greater number of samples than previous systems.

[0003] However, there is also an increasing need to provide biological analysis systems with greater flexibility to handle both low throughput and high throughput sample analyses while still providing a faster and more efficient automated system.

Summary of the Invention

[0004] In an ~~embodiment~~ aspect of the present invention, a biological analysis system is provided. The system comprises an interchangeable assembly configured to accommodate any one of a plurality of sample holders, the assembly comprising elements for heating and cooling, a heat exchanger and a sample block, each respective sample holder configured to receive a plurality of samples. The system also includes a control system configured to cycle the plurality of samples through a series of temperatures. The system further includes an optical system configured to detect fluorescent signals emitted from the plurality of samples. The optical system, in particular, can comprise a single field lens, an excitation source, an optical sensor, and a plurality of filter components. The excitation source can be one or more light emitting diodes. The field lens can be a bi-convex lens.

[0005] In ~~another~~ an embodiment, the plurality of sample holders can include, for example, a 96-well block, a 384-well block, a low-density array, or a through-hole array. In an alternative embodiment, the sample holder is a through-hole array. The through-hole array can comprise 48 locations, each location including a subarray having dimensions of 8 through holes by 8 through holes.

[0006] In yet another embodiment, the optical system can be further configured to confirm that the sample holder is properly positioned on the interchangeable assembly.

[0007] In a further embodiment, the sample holder can further include an identifier that references a data file storing data related to the sample holder. The optical system can be further configured to image the identifier to confirm that the correct sample holder is positioned on the interchangeable assembly.

[0008] In yet a further embodiment, the biological system can further include a temperature control system configured to maintain the excitation source within a defined temperature range. The temperature control system can comprise a fan configured to operate intermittently to maintain the excitation source within a defined temperature range.

[0009] In ~~an embodiment of the present invention~~accordance with the present disclosure, a biological analysis system is provided. The system comprises a thermal cycler. The thermal cycler includes a block assembly, an optical system, a user interface, and a processor. The block assembly can be configured to receive a plurality of samples and cycle the plurality of samples through a series of temperatures. The optical system can comprise an optical sensor configured to detect a fluorescence level emitted from each of the plurality of samples. The user interface can be integrated on an exterior surface thermal cycler device. The processor can be programmed to process the detected fluorescence levels and display the fluorescence levels on the integrated user interface in real-time, wherein the parameters for displaying fluorescent levels are changeable based on user preference.

[0010] ~~In another embodiment~~As disclosed, the parameters can be, for example, a selection of one or more sample holders that receive the plurality of samples, a selection one or more wells within

the one or more sample holders, a selection of one or more dyes within the one or more wells, or combinations thereof. The one or more sample holders can include, for example, a 96-well block, a 384-well block, a low-density array, and a through-hole array.

[0011] ~~In yet another embodiment~~As disclosed, the processor can be programmed to display the fluorescence levels in the form of real-time amplification plots.

[0012] ~~In a further embodiment~~As disclosed, the block assembly is an interchangeable block assembly which can accommodate any one of a 96-well block, a 384-well block, a low-density array, and a through-hole array, wherein the processor is programmed to display the fluorescence levels in the form of real-time amplification plots for any one of the plurality of sample holders.

[0013] In ~~an embodiment of the present invention~~accordance with the present disclosure, a biological analysis system is provided. The system includes a block assembly configured to accommodate one or more cases, wherein each case is configured accommodate a sample holder that receives a plurality of samples. The system also includes a cover comprising. The cover can have a frame having a contact surface, a platen, a sealing material and a heat source. The sealing material can be configured to contact the block assembly to form an enclosed volume of air between the sample holders and the platen. The heat source can be configured to heat the enclosed volume of air to prevent (a) condensation on the one or more cases and (b) thermal non-uniformity of the sample holders when the sample holders are cycled through a series of temperatures.

[0014] ~~In another embodiment~~As disclosed, the sealing material is a gasket formed to the contact surface of the frame. The gasket can be configured and arranged to contact the block assembly and not contact the sample holders.

[0015] ~~In yet another embodiment~~As disclosed, the block assembly can further include a carrier shaped to accommodate the one or more cases, wherein the sealing material is arranged to form to the carrier.

[0016] ~~In a further embodiment~~As disclosed, the one or more cases can include a thermally conductive material. The thermally conductive material is selected from the group consisting of aluminum, graphite, zinc, berilum, stainless steel, and combinations thereof.

[0017] ~~In yet a further embodiment~~As disclosed, the platen can include one or more transparent plates each positioned directly above a corresponding sample holder. One of the transparent plates can have substantially the same dimensions as the corresponding sample holder. The transparent plates can also positioned at an angle relative to the sample holder to prevent reflection of light passing through the one or more transparent plates. Further, the transparent plates can be glass plates.

[0018] In ~~an embodiment of the present invention~~accordance with the present disclosure, a biological analysis system is provided. The system includes a block assembly configured to accommodate one or more cases, wherein each case is configured accommodate a sample holder that receives a plurality of samples. The system also includes a data file and a fill station. The data file has instructions for arranging the plurality of samples onto a plurality of sample locations on the one or more sample holders. The instructions can be, for example, sample loading instructions, assay definitions for each sample, sample location definitions, or combinations thereof.

[0019] The fill station can include a processor configured to execute the instructions, wherein the fill station is configured to load each sample holder with a plurality of samples according to the executed instructions. The processor can be further configured to modify the received data file with information selected from the group consisting of updated sample locations, updated positional locations, and combinations thereof

[0020] ~~In another embodiment~~As disclosed, each of the cases is constructed and arranged to accept a case cover to enclose each of the loaded sample holders and provide a sealed interior within each case and corresponding case cover. Each case or each corresponding case cover can be configured to receive a liquid that is immiscible with the samples into the sealed interior. The immiscible liquid can be a perfluorinated hydrocarbon, a hydrocarbon, an oil, or a silicone fluid.

[0021] ~~In yet another embodiment~~As disclosed, the system further includes an automated device for transferring loaded sample holders from the fill station to the block assembly.

[0022] ~~In a further embodiment~~As disclosed, at least one sample holder comprises an identifier, which can be a barcode.

[0023] In ~~an embodiment of the present invention~~accordance with the present disclosure, a biological analysis system is provided. The system includes a block assembly, a data file that stores instructions, an optical system and a processor. The block assembly can be configured to accommodate one or more sample holders loaded with a plurality of samples, wherein the sample holders includes an identifier. The identifier can be a barcode. The optical system can be configured to (a) detect fluorescent signals emitted from the plurality of samples and (b) image the identifier to identify the data file and identify the sample holder

[0024] ~~In an embodiment~~As disclosed, processor executes instructions of the identified data file to cycle the plurality of samples though a series of temperatures. The instructions can be, for example, sample loading instructions, assay definitions for each sample, sample location definitions, or combinations thereof.

[0025] Additional aspects, features, and advantages of the present invention are set forth in the following description and claims, particularly when considered in conjunction with the accompanying drawings in which like parts bear like reference numbers.

Brief Description of the Drawings

[0026] Embodiments of the present invention may be better understood from the following detailed description when read in conjunction with the accompanying drawings. Such embodiments, which are for illustrative purposes only, depict novel and non-obvious aspects of the invention. The drawings include the following figures:

[0027] FIG. 1 is a block diagram that illustrates an exemplary instrument, upon which embodiments of the present teachings may be implemented.

WHAT IS CLAIMED IS:

1. A biological analysis system comprising:

an interchangeable assembly configured to accommodate any one of a plurality of sample holders, the assembly comprising elements for heating and cooling, a heat exchanger and a sample block, each respective sample holder configured to receive a plurality of samples;

a control system configured to cycle the plurality of samples through a series of temperatures; and

an optical system configured to detect fluorescent signals emitted from the plurality of samples, wherein the optical system comprises:

a single field lens;

an excitation source;

an optical sensor; and

a plurality of filter components.

2. The biological analysis system of Claim 1, wherein the plurality of sample holders are selected from the group consisting of a 96-well block, a 384-well block, a low-density array, and a through-hole array.

3. The biological analysis system of Claim 1, wherein the optical system is further configured to confirm that the sample holder is properly positioned on the interchangeable assembly.

4. The biological analysis system of Claim 1, wherein the sample holder further comprises an identifier that references a data file storing data related to the sample holder, and wherein the optical system is further configured to image the identifier to confirm that the correct sample holder is positioned on the interchangeable assembly.

5. The biological analysis system of Claim 1, wherein the excitation source is one or more light emitting diodes.

6. The biological analysis system of Claim 1, further comprising a temperature control system configured to maintain the excitation source within a defined temperature range.

7. The biological analysis system of Claim 6, wherein the temperature control system comprises a fan configured to operate intermittently to maintain the excitation source within a defined temperature range.

8. The biological analysis system of Claim 1, wherein the field lens is a bi-convex lens.

9. The biological analysis system of Claim 2, wherein the sample holder is a through-hole array.

10. The biological analysis system of Claim 9, wherein the through-hole array comprising 48 locations, each location including a subarray having dimensions of 8 through holes by 8 through holes.

~~11. A biological analysis system comprising:~~

~~a thermal cycler comprising:~~

~~a block assembly configured to receive a plurality of samples and cycle the plurality of samples through a series of temperatures;~~

~~an optical system comprising an optical sensor configured to detect a fluorescence level emitted from each of the plurality of samples;~~

~~a user interface integrated on an exterior surface thermal cycler device; and~~

~~a processor programmed to process the detected fluorescence levels and display the fluorescence levels on the integrated user interface in real-time, wherein the parameters for displaying fluorescent levels are changeable based on user preference.~~

~~12. The biological analysis system of Claim 11, wherein the parameters are selected from the group consisting of a selection of one or more sample holders that receive the plurality~~

~~of samples, a selection one or more wells within the one or more sample holders, a selection of one or more dyes within the one or more wells, and combinations thereof.~~

~~13. The biological analysis system of Claim 12, wherein the one or more sample holders are selected from the group consisting of a 96-well block, a 384-well block, a low-density array, and a through-hole array.~~

~~14. The biological analysis system of Claim 11, wherein the processor is programmed to display the fluorescence levels in the form of real-time amplification plots.~~

~~15. The biological analysis system of Claim 12, wherein the block assembly is an interchangeable block assembly and is configured to accommodate any one of a plurality of sample holders selected from the group consisting of a 96-well block, a 384-well block, a low-density array, and a through-hole array, and wherein the processor is programmed to display the fluorescence levels in the form of real-time amplification plots for any one of the plurality of sample holders.~~

~~16. A biological analysis system comprising:~~

~~a block assembly configured to accommodate one or more cases, wherein each case is configured accommodate a sample holder that receives a plurality of samples;~~

~~a cover comprising:~~

~~a frame having a contact surface;~~

~~a platen;~~

~~a sealing material configured to contact the block assembly to form an enclosed volume of air between the sample holders and the platen; and~~

~~a heat source configured to heat the enclosed volume of air to prevent (a) condensation on the one or more cases and (b) thermal non-uniformity of the sample holders when the sample holders are cycled through a series of temperatures.~~

~~17. The biological analysis system of Claim 16, wherein the sealing material is a gasket formed to the contact surface of the frame.~~

~~18. The biological analysis system of Claim 17, wherein the gasket is configured and arranged to contact the block assembly and not contact the sample holders.~~

~~19. The biological analysis system of Claim 16, wherein the block assembly further comprises a carrier shaped to accommodate the one or more cases, wherein the sealing material is arranged to form to the carrier.~~

~~20. The biological analysis system of Claim 16, wherein the one or more cases include a thermally conductive material.~~

~~21. The biological analysis system of Claim 20, wherein the thermally conductive material is selected from the group consisting of aluminum, graphite, zinc, berilum, stainless steel, and combinations thereof.~~

~~22. The biological analysis system of Claim 16, wherein the platen comprises one or more transparent plates each positioned directly above a corresponding sample holder.~~

~~23. The biological analysis system of Claim 22, wherein each one of the one or more transparent plates have substantially the same dimensions as the corresponding sample holder.~~

~~24. The biological analysis system of Claim 22, wherein the one or more transparent plates are positioned at an angle relative to the sample holder to prevent reflection of light passing through the one or more transparent plates.~~

~~25. The biological system of Claim 22, wherein the transparent plates are glass plates.~~

~~26. A biological analysis system comprising:~~

~~a block assembly configured to accommodate one or more cases, wherein each case is configured to accommodate a sample holder loaded with a plurality of samples;~~

~~a data file having instructions for arranging the plurality of samples onto a plurality of sample locations on the one or more sample holders; and~~

~~a fill station having a processor configured to execute the instructions, wherein the fill station is configured to load each sample holder with a plurality of samples according to the executed instructions.~~

~~27. The biological analysis system of Claim 26, wherein each of the one or more cases are constructed and arranged to accept a case cover to enclose each of the loaded sample holders and provide a sealed interior within each case and corresponding case cover.~~

~~28. The biological analysis system of Claim 27, wherein each case or each corresponding case cover is configured to receive a liquid that is immiscible with the samples into the sealed interior.~~

~~29. The biological analysis system of Claim 26, further comprising an automated device for transferring loaded sample holders from the fill station to the block assembly.~~

~~30. The biological analysis system of Claim 26, the instructions selected from the group consisting of sample loading instructions, assay definitions for each sample, sample location definitions, and combinations thereof.~~

~~31. The biological analysis system of Claim 26, wherein at least one sample holder comprises an identifier.~~

~~32. The biological analysis system of Claim 31, wherein the identifier is a barcode.~~

~~33. The biological analysis system of Claim 26, wherein the processor is configured to modify the received data file with information selected from the group consisting of updated sample locations, updated positional locations, and combinations thereof.~~

~~34. The biological analysis system of Claim 28, wherein the immiscible liquid is a perfluorinated hydrocarbon, a hydrocarbon, an oil, or a silicone fluid.~~

~~35. A biological analysis system comprising:~~

~~a block assembly configured to accommodate one or more sample holders loaded with a plurality of samples, wherein the sample holders includes an identifier;~~

~~a data file which stores instructions;~~

~~an optical system configured to (a) detect fluorescent signals emitted from the plurality of samples and (b) image the identifier to identify the data file and identify the sample holder; and~~

~~a processor that executes instructions of the identified data file to cycle the plurality of samples though a series of temperatures.~~

~~36. The biological analysis system of Claim 35, wherein the instructions are selected from the group consisting of sample loading instructions, assay definitions for each sample, sample location definitions, and combinations thereof.~~

~~37. The biological analysis system of Claim 35, wherein the identifier is a barcode.~~