Systems and Methods for Assessing Biological Samples

Background of the Invention

Field of the Invention

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 comprising an optical system for observing, testing, and/or analyzing one or more biological samples.

Description of the Related Art

Summary

An aspect of the present invention provides an instrument for biological analysis, comprising an excitation source; an optical sensor configured to receive emissions from biological samples in response to the excitation source; an optical sensor circuit board; an excitation optical system disposed along an excitation optical path; an emission optical system disposed along an emission optical path; and an imaging unit. The imaging unit comprises a first surface, an opposing second surface and a threaded housing together forming a cavity that contains the optical sensor; a sensor lens; a lens case at least partially enclosing the lens sensor and having a threaded portion that engages with a threaded portion of the threaded housing; and a focusing mechanism comprising a focusing gear arranged to engage gear teeth provided to an outer surface of the lens case, rotation of the focusing gear rotating the lens case to cause the sensor lens to move along an optical axis of the sensor lens by means of the threads in the lens case and the threaded housing. The first surface comprises a surface of the sensor lens. The second surface comprises the optical sensor circuit board. The focusing mechanism is configured to be accessible from outside an optical enclosure enclosing the optical paths for adjusting a focus of the sensor lens.

Brief Description of the Drawings

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:

FIG. 1 is a schematic representation of a system according to an embodiment of the present invention.

FIG. 2 is a schematic representation of an excitation source according to an embodiment of the present invention.

FIG. 3 is a normalized spectrum plot of various light sources, including a light source according to an embodiment of the present invention.

FIG. 4 is plot of spectral integration over various wavelength ranges for the light source spectrums shown in FIG. 3

FIGS. 5 and 6 are perspective views of an instrument housing according to an embodiment of the present invention.

FIG. 7 is a solid model representation of an optical and sample processing system according to an embodiment of the present invention.

FIG. 8 is a magnified, solid model representation of the optical system shown in FIG. 7.

FIG. 9 is an exploded view of a portion of the sample processing system shown in FIG. 7.

CLAIMS

1. An instrument for biological analysis, comprising:

an excitation source;

an optical sensor configured to receive emissions from biological samples in response to the excitation source;

an optical sensor circuit board;

an excitation optical system disposed along an excitation optical path;

an emission optical system disposed along an emission optical path; and

an imaging unit comprising:

a first surface, an opposing second surface and a threaded housing together forming a cavity that contains the optical sensor;

a sensor lens;

a lens case at least partially enclosing the lens sensor and having a threaded portion that engages with a threaded portion of the threaded housing; and

a focusing mechanism comprising a focusing gear arranged to engage gear teeth provided to an outer surface of the lens case, rotation of the focusing gear rotating the lens case to cause the sensor lens to move along an optical axis of the sensor lens by means of the threads in the lens case and the threaded housing;

wherein the first surface comprises a surface of the sensor lens;

wherein the second surface comprises the optical sensor circuit board; and

wherein the focusing mechanism is configured to be accessible from outside an optical enclosure enclosing the optical paths for adjusting a focus of the sensor lens.

2. The instrument according to claim 1, further comprising a beamsplitter disposed along both the excitation optical path and along the emission optical path.

3. The instrument according to claims 1 or 2, wherein the excitation source is configured to provide a plurality of excitation beams to illuminate the biological samples, and wherein at least

some of the emissions comprise a fluorescent emission from at least some of the biological samples in response to at least one of plurality of the excitation beams.

4. The instrument according to claim 3, wherein a base of the instrument comprises a thermal controller, and, optionally, wherein the thermal controller is configured to control a temperature of at least one of the base, the sample holder, or the separated biological samples, or optionally, wherein the thermal controller comprises a thermal cycler configured to perform a PCR assay.

5. The instrument according to claim 4, wherein the excitation optical system comprises a sample lens configured to direct the excitation beams toward the base, wherein the sample lens comprises a field lens configured to extend over a plurality of spatially separated reaction regions, and wherein the sample lens is configured to provide a telecentric optical system for at least one of the sample holder, the spatially separated reaction regions, or the optical sensor.

6. The instrument according to claim 2:

wherein the beamsplitter is characterized by a reflectance that is constant over a wavelength band from 450 nanometers to 690 nanometers.

7. The instrument according to claim 3, wherein the plurality of excitation beams comprise a first excitation beam that is characterized by a first wavelength and comprises a first wavelength range over which an intensity, power or energy of the first excitation beam is above a first predetermined value, and a second excitation beam that is characterized by a second wavelength and comprises a second wavelength range over which an intensity, power, or energy of the second excitation beam is above a second predetermined value, and wherein the first wavelength is at least one of (1) a central wavelength of the first wavelength range or (2) a wavelength of maximum electromagnetic intensity, power, or energy over the first wavelength range, and the second wavelength is at least one of (1) a central wavelength of the second wavelength range or (2) a wavelength of maximum electromagnetic intensity, power, or energy over the second wavelength range.

8. The instrument according to claim 7, wherein the first excitation beam and the second excitation beam are temporally separated and/or spatially separated.

9. The instrument according to claim 1, wherein the excitation source comprises a plurality of individual excitation sources.

10. The instrument according to claim 9, wherein the plurality of individual excitation sources form a two dimensional array of individual excitation sources.

11. The instrument according to claim 1, wherein the optical sensor comprises an array sensor.

12. The instrument according to claim 11, wherein the array sensor comprises at least one of a complementary metal-oxide-semiconductor sensor or a charge-coupled device sensor.

13. The instrument according to claim 1, where in the optical sensor comprises at least two array sensors.

14. The instrument according to claim 1, further comprising a heated cover disposed adjacent a base and including a plurality of apertures configured to correspond to a plurality of reaction regions.