

an excitation optical system comprising a light source configured to simultaneously illuminate the at least 20,000 separate reaction sites;

an optical sensor comprising a predetermined number of pixels, the predetermined number of pixels being at least 20 times the number of reaction sites; ~~and~~

an emission optical system comprises a system working distance from the sample holder, wherein the system working distance is less than or equal to 60 millimeters; and

a beamsplitter configured to reflect excitation light from the excitation optical system to the sample and to transmit emission light from the sample to the optical sensor.

According to another aspect of the present invention, there is provided a system for determining the number of target nucleotide molecules in a sample, comprising:

a sample holder configured to receive an article comprising a plurality of separate reaction sites;

an image recording system comprising ~~the~~ an optical sensor; and

a housing comprising:

an excitation optical system comprising a light source configured to simultaneously illuminate the separate reaction sites;

an emission optical system configured to transfer radiation from the article to the image recording system; and

a beamsplitter configured to reflect excitation light from the excitation optical system to the sample and to transmit emission light from the sample to the optical sensor;

wherein the image recording system is detachably mounted to the housing.

According to another aspect of the present invention, there is provided a method of measuring an amount of a target nucleotide in one or more samples, the method comprising:

providing a system comprising:

a sample holder configured to receive an article comprising at least 20,000 separate reaction sites;

an excitation optical system comprising a light source configured to simultaneously illuminate the at least 20,000 separate reaction sites;

an optical sensor comprising a predetermined number of pixels, the predetermined number of pixels being at least 20 times the number of reaction sites; and
an emission optical system comprises a system working distance from the sample holder, wherein the system working distance is less than or equal to 60 millimeters; and
a beamsplitter configured to reflect excitation light from the excitation optical system to the sample and to transmit emission light from the sample to the optical sensor
providing the article;
performing an amplification assay on at least some of the at least 20,000 reaction sites;
placing the article in the sample holder;
illuminating the article using the excitation optical system;
measuring emission radiation from at least some of the at least 20,000 separate reaction sites; and
determining an amount of the target nucleotide.

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:

WHAT IS CLAIMED IS:

1. A system for determining the number of target nucleotide molecules in a sample, the system comprising:

a sample holder configured to receive an article comprising at least 20,000 separate reaction sites;

an excitation optical system comprising a light source configured to simultaneously illuminate the at least 20,000 separate reaction sites;

an optical sensor comprising a predetermined number of pixels, the predetermined number of pixels being at least 20 times the number of reaction sites; and

an emission optical system comprises a system working distance from the sample holder, wherein the system working distance is less than or equal to 60 millimeters; and

a beamsplitter configured to reflect excitation light from the excitation optical system to the sample and to transmit emission light from the sample to the optical sensor.

2. The system of claim 1, further comprising a computer including a processor and an electronic memory in communication with the processor, wherein:

the computer receives images from the optical sensor of the at least 20,000 separate reaction sites;

the memory comprises instructions for performing a digital PCR calculation; and

the computer is configured to calculate, based on the instructions and received images, a number of target nucleotide particles contained in at least some of the at least 20,000 separate reaction sites.

3. The system of claim 1, further comprising:

a housing containing excitation optical system and the emission optical system; and

an image recording system comprising the optical sensor;

wherein the image recording system is detachably mounted to the housing.

4. The system of claim 3, wherein the image recording system is a camera phone or a smartphone.

5. The system of claim 3, wherein the image recording system is an iPhone.

6. The system of claim 3, wherein the image recording system comprises a processor configured to acquire images from the optical sensor and to process the images to provide biochemical information of the sample.

7. A system for determining the number of target nucleotide molecules in a sample, comprising:

a sample holder configured to receive an article comprising a plurality of separate reaction sites;

an image recording system comprising ~~the~~ an optical sensor; and

a housing comprising:

an excitation optical system comprising a light source configured to simultaneously illuminate the separate reaction sites;

an emission optical system configured to transfer radiation from the article to the image recording system; and

a beamsplitter configured to reflect excitation light from the excitation optical system to the sample and to transmit emission light from the sample to the optical sensor;

wherein the image recording system is detachably mounted to the housing.

8. The system of claim 7, wherein the image recording system is a camera phone or a smartphone.

9. The system of claim 7, wherein the image recording system is an iPhone.

10. The system of claim 7, wherein image recording system comprises a processor configured to acquire images from the optical sensor and to process the images to provide biochemical information of the sample.

11. A method of measuring an amount of a target nucleotide in one or more samples, the method comprising:

providing a system comprising:

a sample holder configured to receive an article comprising at least 20,000 separate reaction sites;

an excitation optical system comprising a light source configured to simultaneously illuminate the at least 20,000 separate reaction sites;

an optical sensor comprising a predetermined number of pixels, the predetermined number of pixels being at least 20 times the number of reaction sites; ~~and~~

an emission optical system comprises a system working distance from the sample holder, wherein the system working distance is less than or equal to 60 millimeters; and
a beamsplitter configured to reflect excitation light from the excitation optical system to the sample and to transmit emission light from the sample to the optical sensor;
providing the article;
performing an amplification assay on at least some of the at least 20,000 reaction sites;
placing the article in the sample holder;
illuminating the article using the excitation optical system;
measuring emission radiation from at least some of the at least 20,000 separate reaction sites; and
determining an amount of the target nucleotide.

12. The method of claim 11, further comprising:
dividing at least a portion of a sample solution containing the target nucleotide between at least some of the at least 20,000 reaction sites;
determining an amount of the target nucleotide in the solution by measuring emission radiation from at least some of the at least 20,000 reaction sites.

13. The method of claim 12, further comprising
dividing at least a portion of a sample solution containing the target nucleotide between the reaction sites of a plurality of articles, each article comprising the at least 20,000 reaction sites;
determining an amount of the target nucleotide in the solution by measuring emission radiation from at least some of reaction sites of each of the plurality of articles.

14. The method of claim 12, further comprising
dividing at least a portion of a sample solution containing the target nucleotide between the reaction sites of a plurality of articles, each article comprising the at least 20,000 reaction sites;
sequentially placing each article of the plurality of articles in the sample holder and measuring emission radiation from at least some of the at least 20,000 separate reaction sites of each article;
determining an amount of the target nucleotide in the solution based on measured emission radiation all of the plurality of articles.