to detect changes in signal by an optical pickup (Patent Literature 2).

CITATION LIST

PATENT LITERATURE

[0004]

Patent Literature 1: Japanese Unexamined Patent Application Publication No. H05-005741

Patent Literature 2: Japanese Translation of PCT International Application Publication No. 2002-530786

SUMMARY OF INVENTION

[0005]

The technology disclosed in Patent Literature 1 or 2, however, may fail to obtain detection signals corresponding to particles depending on the type and arrangement of the particles used. Such failure leads to inaccurate counting results, which may decrease the performance of quantitative analysis of analytes.

[0006]

In view of the foregoing, an object of the present invention is to provide an analysis device and an analysis method with improved quantitative analysis of analytes.

[0007]

In order to achieve the object, a first aspect of the present invention is an analysis device including: an optical scanning unit ~~(3)~~ configured to optically scan a surface of a substrate ~~(100)~~ to which analytes ~~(620)~~ and particles ~~(66)~~ for labeling the analytes ~~(620)~~ are fixed; a pulse detector ~~(51)~~ configured to detect a pulse wave and a pulse width of the pulse wave included in a detection signal obtained from the optical scanning unit ~~(3)~~ when the optical scanning unit ~~(3)~~ scans the

substrate; and a counting unit ~~(50)~~ configured to count the analytes ~~(620)~~ and determine that an analyte count is one when the pulse detector ~~(51)~~ consecutively detects two pulse waves each having a pulse width ~~(Ta)~~ less than a first reference value ~~(T2)~~.

[0008]

A second aspect of the present invention is an analysis method including: optically scanning a surface of a substrate ~~(100)~~ to which analytes ~~(620)~~ and particles ~~(66)~~ for labeling the analytes ~~(620)~~ are fixed; detecting a pulse wave and a pulse width of the pulse wave included in a detection signal obtained by scanning the substrate ~~(100)~~; and counting the analytes ~~(620)~~ and determining that an analyte count is one when consecutively detecting two pulse waves each having a pulse width ~~(Ta)~~ less than a first reference value ~~(T2)~~ in the detection signal.

BRIEF DESCRIPTION OF DRAWINGS

[0009]

[Fig. 1] Fig. 1 is a schematic block diagram for describing a fundamental configuration of an analysis device according to an embodiment of the present invention.

[Fig. 2] Fig. 2(a) to Fig. 2(f) are enlarged cross-sectional views each schematically showing a substrate of the analysis device according to the embodiment of the present invention, for describing an example of a method of fixing antibodies, antigens, and beads to the substrate.

[Fig. 3] Fig. 3 is a schematic view for describing a state in which two beads 66 are bound to one exosome on the substrate.

[Fig. 4] Fig. 4 is a view showing simulation results of detection of adjacent beads while varying the number of beads, for describing characteristics of a spot position and signal intensity when scanning the substrate.

The analysis revealed that the count is entirely smaller in the curved line P1~~P2~~ than the curved line P2~~P1~~ regardless of the biomarker concentration. ~~As indicated by the broken lines along the respective curved lines P1 and P2,~~ When the biomarker content is zero, the count would ideally result in zero. In the detection method by use of the antigen-antibody reaction, however, nonspecific adsorption appears on the substrate 100 other than the binding by the antigen-antibody reaction. Even when the biomarker concentration is zero, the beads 66 fixed to the surface of the substrate 100 due to the nonspecific adsorption are thus inevitably counted.

[0061]

In the respective curved lines P1 and P2, the upper limits of error Q1 and Q2 at which the biomarker concentration of the respective curved lines P1 and P2 is zero (plots at the leftmost end in Fig. 11) are referred to as background noise. The points of contact (points of intersection) between the background noise and the lower limits of error at each plot are respectively denoted by the limits of detection R1 and R2. The counted results by the conventional method each denote the actual number of beads 66 and vary in each test (analysis), and therefore lead to an increase in variation. The counted results by the analysis device according to the embodiment of the present invention are obtained according to "the count of beads = the number of exosomes", so as to minimize variations even when the test (analysis) is repeated. The limit of detection R1 in the analysis device according to the embodiment of the present invention is therefore improved compared with the limit of detection R2 in the conventional method, and it is apparent that the sensitivity of the biomarker detection is improved. Accordingly, the analysis device according to the embodiment of the present invention can improve the sensitivity for

[Claim 1]

An analysis device comprising:

an optical scanning unit configured to optically scan a surface of a substrate to which analytes and particles for labeling the analytes are fixed;

a pulse detector configured to detect a pulse wave and a pulse width of the pulse wave included in a detection signal obtained from the optical scanning unit when the optical scanning unit scans the substrate; and

a counting unit configured to count the analytes and determine that an analyte count is one when the pulse detector consecutively detects two pulse waves each having a pulse width less than a first reference value.

[Claim 2]

The analysis device according to claim 1, wherein the counting unit determines that the analyte count is one when the pulse detector detects a pulse wave having a pulse width greater than or equal to the first reference value and less than a second reference value.

[Claim 3]

The analysis device according to claim 1 or 2, wherein, when the pulse detector detects a first pulse wave having a pulse width less than the first reference value, detects a second pulse wave after the first pulse wave, and a pulse interval between the first pulse wave and the second pulse wave is greater than or equal to a third reference value, the counting unit does not implement counting processing with regard to both the first pulse wave and the second pulse wave.

[Claim 4]

The analysis device according to claim 2 or 3, wherein, when the pulse detector detects a first pulse wave having a pulse

width less than the first reference value and subsequently detects the pulse wave having the pulse width greater than or equal to the first reference value and less than the second reference value, the counting unit does not implement counting processing with regard to the first pulse wave.

[Claim 5]

The analysis device according to any one of claims 2 to 4, wherein, when the pulse detector detects a pulse wave having a pulse width greater than or equal to the second reference value, the counting unit does not implement counting processing with regard to the pulse wave having the pulse width greater than or equal to the second reference value.

[Claim 6]

The analysis device according to any one of claims 1 to 5, wherein the first reference value is a sum of the first pulse width and a jitter value included in the detection signal.

[Claim 7]

The analysis device according to any one of claims 2 to 6, wherein the second reference value is a sum of the second pulse width and a jitter value included in the detection signal.

[Claim 8]

An analysis method comprising:

optically scanning a surface of a substrate to which analytes and particles for labeling the analytes are fixed;

detecting a pulse wave and a pulse width of the pulse wave included in a detection signal obtained by scanning the substrate; and

counting the analytes and determining that an analyte count is one when consecutively detecting two pulse waves each having a pulse width less than a first reference value in the detection signal.

CLAIMS

[Claim 1]

An analysis device comprising:

an optical scanning unit configured to optically scan a surface of a substrate to which analytes and particles for labeling the analytes are fixed;

a pulse detector configured to detect a pulse wave and a pulse width of the pulse wave included in a detection signal obtained from the optical scanning unit when the optical scanning unit scans the substrate; and

a counting unit configured to count the analytes and determine that an analyte count is one when the pulse detector consecutively detects two pulse waves each having a pulse width less than a first reference value.

[Claim 2]

The analysis device according to claim 1, wherein the counting unit determines that the analyte count is one when the pulse detector detects a pulse wave having a pulse width greater than or equal to the first reference value and less than a second reference value.

[Claim 3]

The analysis device according to claim 1 or 2, wherein, when the pulse detector detects a first pulse wave having a pulse width less than the first reference value, detects a second pulse wave after the first pulse wave, and a pulse interval between the first pulse wave and the second pulse wave is greater than or equal to a third reference value, the counting unit does not implement counting processing with regard to both the first pulse wave and the second pulse wave.

[Claim 4]

The analysis device according to claim 2, wherein, when the pulse detector detects a first pulse wave having a pulse

width less than the first reference value and subsequently detects the pulse wave having the pulse width greater than or equal to the first reference value and less than the second reference value, the counting unit does not implement counting processing with regard to the first pulse wave.

[Claim 5]

The analysis device according to claim 2 or 4, wherein, when the pulse detector detects a pulse wave having a pulse width greater than or equal to the second reference value, the counting unit does not implement counting processing with regard to the pulse wave having the pulse width greater than or equal to the second reference value.

[Claim 6]

The analysis device according to any one of claims 1 to 5, wherein the first reference value is a sum of a first pulse width and a predetermined value included in the detection signal.

[Claim 7]

The analysis device according to any one of claims 2, 4 and 5, wherein the second reference value is a sum of a second pulse width and a predetermined value included in the detection signal.

[Claim 8]

An analysis method comprising:

optically scanning a surface of a substrate to which analytes and particles for labeling the analytes are fixed;

detecting a pulse wave and a pulse width of the pulse wave included in a detection signal obtained by scanning the substrate; and

counting the analytes and determining that an analyte count is one when consecutively detecting two pulse waves each having a pulse width less than a first reference value in the detection signal.