gradients exist within the material of the block, causing some samples to have different temperatures than others at particular times in the cycle. Because the chemical reaction of the mixture has an optimum temperature for each or its stages, achieving that actual temperature is critical for good analytical results. A large TNU can cause the yield of the PCR process to differ from sample vial to sample vial.

[0004] As such, the analysis of TNU is an important attribute for characterizing the performance of a thermal block assembly, which may be used in various bioanalysis instrumentation. The TNU is typically measured in a sample block portion of a thermal block assembly, and is typically expressed as either the difference or the average difference between the hottest well and the coolest position on the sample block portion engaging a sample or samples. The industry standard, set in comparison with gel data, a difference of about 1.0 °C, or an average difference of 0.5 °C. Historically, the focus on reducing TNU has been focused on the sample block. For example, it has been observed that the edges of the sample block are typically cooler than the center. One approach that has been taken to counteract such edge effects is to provide various perimeter and edge heaters around the sample block to offset the observed thermal gradient from the center to the edges.

SUMMARY

[0005] In an aspect~~exemplary embodiment~~, a method for performing polymerase chain reactions (PCR) includes measuring a first temperature, by a first sensor, of a first sample block sector of a sample block ~~using a thermoelectric controller~~, and measuring a second temperature, by a second sensor, of a second sample block sector of the sample block that is adjacent to the first sample block sector ~~using the thermoelectric controller~~. The method further includes calculating, by a thermoelectric controller, a difference in temperature between the first temperature and the second temperature. The thermoelectric controller adjusts the first temperature of the first sample block sector based on the difference in temperature by adjusting a power output to one or more thermoelectric coolers. The one or more thermoelectric coolers are configured to heat or cool the first sample block sector.

[0006] In another aspect~~exemplary embodiment~~, a computer-readable storage medium is encoded with instructions executable by a processor, for performing polymerase chain reactions, comprising instructions for measuring a first temperature of a first sample block sector of a sample block ~~using a thermoelectric controller~~, and measuring a second temperature of a second sample block sector of the sample block that is adjacent to the first sample block sector ~~using the thermoelectric controller~~. The instructions are further for calculating a difference in temperature between the first temperature and the second temperature. The instructions

further included instructions for adjusting ~~the power output of the thermoelectric controller to one or more thermoelectric coolers to adjust~~ the first temperature of the first sample block sector based on the difference in temperature based on adjusting a power output to one or more thermoelectric coolers. The one or more thermoelectric coolers are configured to heat or cool the first sample block sector.

[0007] In another aspect~~exemplary embodiment~~, a system for performing polymerase chain reactions (PCR) includes a first sensor configured for detecting a first temperature of a first sample block sector of a sample block, and a second sensor configured for detecting a second temperature of a second sample block sector of the sample block that is adjacent to the first sample block sector. The system further includes a thermoelectric controller in electrical communication with the first sensor and the second sensor. The thermoelectric controller is configured to receive a first temperature of a first sample block sector of a sample block and receive a second temperature of a second sample block sector of the sample block that is adjacent to the first sample block sector. The thermoelectric controller is~~if~~ further configured to calculate a difference in temperature between the first temperature and the second temperature, and to adjust the first temperature of the first sample block sector based on the difference in temperature based on adjusting a power output to one or more thermoelectric coolers. The one or more thermoelectric coolers are~~is~~ configured to heat or cool the first sample block sector.

BRIEF DESCRIPTION OF THE DRAWINGS

[0008] The skilled artisan will understand that the drawings, described below, are for illustration purposes only. The drawings are not intended to limit the scope of the present teachings in any way.

[0009] FIG. 1 is a block diagram of a thermal cycler instrument.

[00010] FIG. 2 is a block diagram of a thermal cycler instrument including a detection system.

[00011] FIG. 3 is a block diagram that illustrates a computer system 700, according to various embodiments, upon which embodiments of methods for the analysis of PBA data may be implemented.

[00012] FIG. 4 illustrates a perspective of an exemplary thermal block assembly.

[00013] FIG. 5 illustrates a generalized schematic that depicts a prior art control system for the thermal block assembly shown in FIG. 4.

[00014] FIG. 6 illustrates a generalized schematic for a prior art control system for the thermal block assembly shown in FIG. 5.

[00015] FIG. 7 illustrates a schematic representation 400 corresponding to an embodiment.

CLAIMS

What is claimed is:

1. A method for performing polymerase chain reactions (PCR), the method comprising:

measuring a first temperature, by a first sensor, of a first sample block sector of a sample block;

measuring a second temperature, by a second sensor, of a second sample block sector of the sample block that is adjacent to the first sample block sector;

calculating, by a thermoelectric controller, a difference in temperature between the first temperature and the second temperature; and

adjusting, by the thermoelectric controller, the first temperature of the first sample block sector based on the difference in temperature based on adjusting a power output to one or more thermoelectric coolers, wherein the one or more thermoelectric coolers is configured to heat or cool the first sample block sector.

2. The method of claim 1, wherein the measuring of the first temperature by the first sensor and the second temperature from the second sensor occurs during a ramping up of the power output to the one or more thermoelectric coolers.

3. The method of claim 1, wherein measuring the first temperature from the first sensor and the second temperature from the second sensor occurs during a ramping down of the power output to the one or more thermoelectric coolers.

4. The method of claim 2, further comprising adjusting the power output to the one or more thermoelectric coolers based on a rate at which the power output to the one or more thermoelectric coolers is ramping up.

5. The method of claim 3, further comprising adjusting the power output to the one or more thermoelectric coolers based on a rate at which the power output to the one or more thermoelectric coolers is ramping down.

6. The method of claim 1, further comprising:

measuring a third temperature, by a third sensor, of a third sample block sector of the sample block;

calculating, by the thermoelectric controller, a difference in temperature between the third temperature and the first temperature and a difference between the third temperature and the second temperature; and

adjusting, by the thermoelectric controller, the first temperature of the first sample block based on the difference between the first temperature and the second temperature, the difference between the third temperature and the first temperature, and the third temperature and the second temperature based on adjusting the power output to the one or more thermoelectric coolers.

7. The method of claim 1, further comprising:

adjusting, by the thermoelectric controller, the second temperature of the second sample block sector based on adjusting a power output to a second set of one or more thermoelectric coolers, wherein the second set of one or more thermoelectric coolers is configured to heat or cool the second sample block sector.

8. A computer-readable storage medium encoded with instructions, executable by a processor, for performing polymerase chain reactions (PCR), the instructions comprising instructions for:

measuring a first temperature of a first sample block sector of a sample block;

measuring a second temperature of a second sample block sector of the sample block that is adjacent to the first sample block sector;

calculating a difference in temperature between the first temperature and the second temperature; and

adjusting the first temperature of the first sample block sector based on the difference in temperature based on adjusting a power output to one or more thermoelectric coolers, wherein the one or more thermoelectric coolers is configured to heat or cool the first sample block sector.

9. The computer-readable medium of claim 8, wherein measuring the first temperature from the first sensor and the second temperature from the second sensor occurs during a ramping up of the power output to the one or more thermoelectric coolers using the thermoelectric controller.

10. The computer-readable medium of claim 8, wherein measuring the first temperature from the first sensor and the second temperature from the second sensor occurs during a ramping down of the power output to the one or more thermoelectric coolers using the thermoelectric controller.

11. The computer-readable medium of claim 8, further comprising adjusting the power output to the one or more thermoelectric coolers based on a rate at which the power output to the one or more thermoelectric coolers.

12. The computer-readable medium of claim 9, further comprising adjusting the power output to the one or more thermoelectric coolers based on a rate at which the power output to the one or more thermoelectric coolers is ramping down.

13. The computer-readable medium of claim 9, wherein the instructions further include instructions for:

measuring a third temperature, by a third sensor, of a third sample block sector of the sample block;

calculating a difference in temperature between the third temperature and the first temperature and a difference between the third temperature and the second temperature; and

adjusting the first temperature of the first sample block based on the difference between the first temperature and the second temperature, the difference between the third temperature and the first temperature, and the third temperature and the second temperature based on adjusting the power output to the one or more thermoelectric coolers.

14. The computer-readable medium of claim 9, wherein the instructions further include instructions for:

adjusting the second temperature of the second sample block sector based on adjusting a power output to a second set of one or more thermoelectric coolers, wherein the second set of one or more thermoelectric coolers is configured to heat or cool the second sample block sector.

15. A system for performing polymerase chain reactions (PCR), the system comprising:

a first sensor configured for detecting a first temperature of a first sample block sector of a sample block;

a second sensor configured for detecting a second temperature of a second sample block sector of the sample block that is adjacent to the first sample block sector; and

a thermoelectric controller in electrical communication with the first sensor and the second sensor, wherein the thermoelectric controller is configured to:

receive a first temperature of a first sample block sector of a sample block,

receive a second temperature of a second sample block sector of the sample block that is adjacent to the first sample block sector,

calculate a difference in temperature between the first temperature and the second temperature, and

adjust the first temperature of the first sample block sector based on the difference in temperature based on adjusting a power output to one or more thermoelectric coolers, wherein the one or more thermoelectric coolers is configured to heat or cool the first sample block sector.

16. The system of claim 15, wherein the thermoelectric controller receives the first temperature from the first sensor and the second temperature from the second sensor during a ramping up of the power output to the one or more thermoelectric coolers.

17. The system of claim 15, wherein the thermoelectric controller receives the first temperature from the first sensor and the second temperature from the second sensor during a ramping down of the power output to the one or more thermoelectric coolers.

18. The system of claim 16, wherein the thermoelectric controller adjusts the power output to the one or more thermoelectric coolers based on a rate at which the power output to the one or more thermoelectric coolers is ramping up in addition to the difference in temperature.

19. The system of claim 16, wherein the thermoelectric controller adjusts the power output of the one or more thermoelectric coolers is further based on a rate at which the power output to the one or more thermoelectric coolers is ramping down.

20. The system of claim 15, wherein the first thermoelectric controller is further configured to:

adjusting the second temperature of the second sample block sector based on adjusting a power output to a second set of one or more thermoelectric coolers, wherein the second set of one or more thermoelectric coolers is configured to heat or cool the second sample block sector.