

HEATER UNIT FOR MICROFLUIDIC DIAGNOSTIC SYSTEM

CLAIM OF PRIORITY

[0001] The instant application claims the benefit of priority to U.S. provisional applications having Ser. Nos. 60/859,284, filed Nov. 14, 2006, and 60/959,437, filed Jul. 13, 2007, the specifications of both of which are incorporated herein by reference in their entireties. The instant application is also a continuation-in-part of U.S. patent application Ser. No. 11/728,964, filed Mar. 26, 2007, the specification of which is incorporated herein by reference in its entirety.

TECHNICAL FIELD

[0002] The technology described herein generally relates to systems for detecting polynucleotides in samples, particularly from biological samples. The technology more particularly relates to microfluidic systems that carry out PCR on nucleotides of interest within microfluidic channels, and detect those nucleotides.

BACKGROUND

[0003] The medical diagnostics industry is a critical element of today's healthcare infrastructure. At present, however, diagnostic analyses no matter how routine have become a bottleneck in patient care. There are several reasons for this. First, many diagnostic analyses can only be done with highly specialist equipment that is both expensive and only operable by trained clinicians. Such equipment is found in only a few locations—often just one in any given urban area. This means that most hospitals are required to send out samples for analyses to these locations, thereby incurring shipping costs and transportation delays, and possibly even sample loss. Second, the equipment in question is typically not available 'on-demand' but instead runs in batches, thereby delaying the processing time for many samples because they must wait for a machine to fill up before they can be run.

[0004] Understanding that sample flow breaks down into several key steps, it would be desirable to consider ways to automate as many of these as possible. For example, a biological sample, once extracted from a patient, must be put in a form suitable for a processing regime that typically involves using PCR to amplify a vector of interest. Once amplified, the presence of a nucleotide of interest from the sample needs to be determined unambiguously. Sample preparation is a process that is susceptible to automation but is also relatively routinely carried out in almost any location, and may still be carried out manually by technicians who require little training. By contrast, steps such as PCR and nucleotide detection have customarily only been within the compass of specially trained individuals having access to specialist equipment.

[0005] There is therefore a need for a method and apparatus of carrying out PCR on prepared biological samples and detecting amplified nucleotides, preferably with high throughput. In particular there is a need for an easy-to-use device that can deliver a diagnostic result on several samples in a short time.

[0006] The discussion of the background to the technology herein is included to explain the context of the technology. This is not to be taken as an admission that any of the material referred to was published, known, or part of the common general knowledge as at the priority date of any of the claims.

[0007] Throughout the description and claims of the specification the word "comprise" and variations thereof, such as "comprising" and "comprises", is not intended to exclude other additives, components, integers or steps.

SUMMARY

[0008] The present technology includes methods and devices for detecting polynucleotides in samples, particularly from biological samples. In particular, the technology relates to microfluidic devices that carry out PCR on nucleotides of interest within microfluidic channels, and permit detection of those nucleotides.

[0009] The technology comprises a heater unit, comprising: a substrate having embedded therein a plurality of groups of resistive heaters, and at least one temperature sensor per group of heaters; and control circuitry for supplying electric current to the plurality of groups of resistive heaters at selected intervals, wherein the substrate has a surface configured to make thermal contact with a microfluidic cartridge having a plurality of PCR reaction chambers, and to deliver heat from the plurality of groups of resistive heaters to regions of the cartridge, such that each of the groups of resistive heaters delivers heat to a select PCR reaction chamber to perform a reaction, wherein the heat delivery from each group of resistive heaters is controlled by sensing temperature using the at least one temperature sensor of the group.

[0010] The technology further comprises a diagnostic apparatus configured to carry out PCR on a number of samples in parallel, wherein the apparatus utilizes a heater unit of claim 1 to apply thermal cycling to each of the samples.

[0011] The technology still further comprises a heater substrate, the substrate comprising: a plurality of groups of resistive heaters, and at least one temperature sensor per group of heaters, wherein the substrate has a surface configured to make thermal contact with a microfluidic substrate having a plurality of PCR reaction chambers, and to deliver heat from one or more of the plurality of groups of resistive heaters to one or more of the PCR reaction chambers so that a PCR reaction takes place therein, and wherein the heat delivery from each group of resistive heaters is controlled by sensing temperature using the at least one temperature sensor of the group.

[0012] The details of one or more embodiments of the technology are set forth in the accompanying drawings and further description herein. Other features, objects, and advantages of the technology will be apparent from the description and drawings, and from the claims.

BRIEF DESCRIPTION OF THE DRAWINGS

[0013] FIG. 1 shows a cross-section of a pipetting head and a cartridge in position in a microfluidic apparatus;

[0014] FIG. 2 shows an exemplary heater unit;

[0015] FIG. 3 shows an exemplary heater chip;

[0016] FIG. 4 shows a cross-section of a microfluidic cartridge, when in contact with a heater substrate;

[0017] FIGS. 5A and 5B show a plan view of heater circuitry adjacent to a PCR reaction chamber;

[0018] FIG. 5C shows thermal images of heater circuitry in operation;

[0019] FIG. 6A shows an exemplary multi-lane cartridge;

[0020] FIG. 6B shows a portion of an exemplary multi-lane cartridge;