

having a significant component substantially aligned with a direction opposite a direction of the electrophoretic motion of the first material. The magnitudes of the electric field, temperature gradient and the flow are such that the first material will accumulate or be focused at a first position along the temperature gradient. A second material is introduced to the fluid so that the second material moves through the first position, thereby interacting with the first material to form a third material. The third material of the interaction is focused at a position along the temperature gradient.

In accordance with another aspect of the present invention, a method is provided for determining the melting temperature of a duplex of a first molecular species and a second molecular species in a fluid. The method includes mixing a first molecular species and a second molecular species in a fluid to form a sample solution containing a duplex. An electric field is applied to the fluid thereby causing the duplex to move electrophoretically with an electrophoretic velocity. A temperature gradient is established in the fluid having a significant component substantially aligned with the electrophoretic motion of the duplex, thereby generating a gradient of the electrophoretic velocity of the duplex. A flow is produced in the fluid having a significant component substantially aligned in a direction opposite a direction of the electrophoretic motion of the duplex wherein magnitudes of electric field temperature gradient and flow are such that the duplex will accumulate or be focused at a position along the temperature gradient. A local temperature around the first position is at a first temperature. A focused band of the duplex is detected at the first position thereby determining an amount of the duplex in the focused band at the first temperature. At least one of the electric field, temperature gradient and the flow are progressively changed so that a local temperature around the focused band becomes progressively different than the first temperature. The amount of the duplex is monitored in the focused band. The amount of the duplex is compared in the focused band at each progressively different temperature thereby determining the melting temperature of the duplex.

In accordance with yet another aspect of the present invention, a method is provided for using a temperature gradient focusing device to determine the melting temperature of duplex of a first molecular species and a second molecular species in a fluid. The temperature gradient focusing device has a temperature gradient. The method includes mixing a first molecular species and a second molecular species in a fluid to form a sample solution containing a duplex. The sample solution is introduced into the temperature gradient focusing device. The operational parameters are adjusted in the temperature gradient focusing device so that the duplex is focused at a position along the temperature gradient. A local temperature around the first position is at a first temperature. The focused band of the duplex is detected at the first position thereby determining the amount of the duplex in the focused band at the first temperature. Progressively, the operational parameters are changed so that the local temperature around the focused band becomes progressively different than the first temperature. The amount of the duplex is monitored in the focused band and the amount of the duplex in the focused band is compared at each progressively different temperature thereby determining the melting temperature of the duplex.

One advantage or feature of the present invention is provided by a technique that allows for simultaneous concentration and separation in a manner similar to isoelectric focusing but which is adoptable for use with any charged material and is not limited to materials for a specific isoelectric point or range of isoelectric points. Further, the temperature gradient focusing of the present invention can be used to achieve

higher degrees of sample concentration, e.g., more than 10,000 fold concentration of a dilute material, when compared with any prior single sample preconcentration method.

A further feature of the present invention is that the electrophoretic velocity gradient is formed within the channel or capillary in response to the temperature gradient without the need for externally manipulated voltages or complicated and difficult to fabricate semi-permeable structures.

Further features and advantages of the present invention will be set forth in, or apparent from, the detailed description of preferred embodiments thereof which follows.

#### BRIEF DESCRIPTION OF THE DRAWINGS

The invention will now be described in detail with respect to preferred embodiments with reference to the accompanying drawings, wherein:

FIG. 1(a) is a schematic depicting a prior art microchannel device which provides for electric field gradient and FIG. 1(b) is a plot of the electric field versus distance (x) along the microchannel of FIG. 1(a);

FIG. 2 is a plot of velocity versus distance along the microchannel of FIG. 1(a);

FIG. 3(a) is a schematic illustration of temperature gradient focusing and fluid conduit in the form of a microchannel in accordance with the present invention, FIG. 3(b) depicts temperature distribution along the microchannel of FIG. 3(a), and FIG. 3(c) is a plot of the function

$$f(T) = \frac{\sigma(20) \cdot \eta(20)}{\sigma(T) \cdot \eta(T)}$$

plotted as a function of the distance along the microchannel of FIG. 3(a), where  $\sigma(T)$  is the temperature dependent conductivity,  $\sigma_0$  is a constant, and  $\eta(T)$  is the temperature dependent viscosity, and FIG. 3(d) is a plot depicting velocity as a function of distance along the microchannel;

FIG. 4(a) is a schematic illustration of a microchannel for temperature gradient focusing created by Joule heating according to another embodiment of the present invention, FIG. 4(b) depicts the temperature profile along a length of the microchannel of FIG. 4(a), FIG. 4(c) is a plot of the function,

$$f(T) = \frac{\sigma(20) \cdot \eta(20)}{\sigma(T) \cdot \eta(T)},$$

plotted as a function of the distance along the microchannel of FIG. 4(a), and FIG. 4(d) is a plot showing electrophoretic velocity, bulk velocity, and total velocity vs. distance along the microchannel of FIG. 4(a);

FIG. 5 is a schematic drawing of a fluidic device according to further embodiment of the present invention;

FIG. 6 is a schematic drawing of a capillary fluidic device according to an alternate embodiment of the present invention;

FIG. 7(a) is a schematic drawing depicting a mixing reaction by temperature gradient focusing prior to the addition of the second material, and FIG. 7(b) is a schematic drawing of the mixing reaction of FIG. 7(a) after the addition of second material in accordance with the present invention;

FIG. 8 is a plot relating intensity versus distance along a temperature gradient prior to the addition of the second material (top panel) and after the addition of the second material (bottom panel); and