

CAPTURING PARTICLES**CROSS-REFERENCE TO RELATED APPLICATIONS**

This application claims priority to U.S. Patent Application No. 61/100,420, entitled Microvortex for focusing, guiding and sorting of particles which was filed on Sep. 26, 2008, the entire contents of which are incorporated herein by reference in their entirety.

BACKGROUND

Microfluidic devices find application in micro total analysis systems (μ TAS) or lab-on-a-chip (LOC) systems because such devices offer the ability to analyze small sample volumes, and can be developed into highly parallel systems at reduced costs. In particular, such systems can be used in biological and clinical applications in which particle manipulation is used to perform operations, for example, concentrating, detecting, sorting, and focusing particulate samples, such as cells and colloids. Passive manipulation of particles flowing through microfluidic devices, by techniques such as hydrodynamic focusing, size filtration, and sedimentation, is relatively simple in comparison to active manipulation using external energy such as optical forces, magnetism, electrokinetics, dielectrophoresis, acoustics, and the like. Passive manipulation does not rely on external sources of energy, but instead can be accomplished using geometries of micro-channels in devices, and flow conditions through such channels. In contrast, active manipulation can employ external sources of energy and can require the integration of powered components to the microfluidic devices.

SUMMARY

This specification describes technologies relating to affinity-based particle capture in microfluidic devices having grooves. When we refer to grooves, we include, for example, long narrow channels (e.g., channels formed extending into and defined by a wall of a larger channel).

In one aspect, methods for capturing particles suspended in a fluid flowed through a micro-channel include: flowing the fluid including the particles to be captured through a micro-channel and past a groove defined in a surface of a wall of the micro-channel; contacting at least some of the particles against an adherent disposed on one or more of walls of the microchannel; and capturing at least some of the particles contacting the adherent.

In one aspect, microfluidic devices include: a micro-channel including: an inlet, an outlet positioned at a distance from the inlet, wherein fluid flows from the inlet to the outlet, and a groove defined into a surface of a wall of the microchannel, the groove including an apex and two ends, each end connected to the apex, the groove oriented such that the fluid flows past the ends towards the apex; and an adherent applied to at least one wall to selectively attach an analyte of interest.

Embodiments can include one or more of the following features alone or in various combinations.

In some embodiments, the adherent is disposed on the surface of the wall in which the groove is defined.

In some embodiments, the groove is defined in a wall of the micro-channel. In some cases, the groove extends into the wall.

In some embodiments, the groove and a plurality of additional grooves are defined in a surface of the wall such that

flowing the fluid past the plurality of additional grooves forms respective microvortices in the fluid.

In some embodiments, flowing the fluid past the groove comprises flowing the fluid past a groove including an apex and two ends, each end connected to the apex, the groove oriented such that the fluid flows past the ends towards the apex. In some cases, the apex and the two ends are defined in the surface in a V shape. A dimension of the groove can be in a range between 3 μ m and 70 μ m.

In some embodiments, flowing the fluid comprises flowing the fluid at an average flow velocity between 2.4 cm/min and 6.0 cm/min.

In some embodiments, the particles are cancer cells and the adherent is an antibody configured to bind the cancer cells. In some cases, methods also include culturing the captured cancer cells.

In some embodiments, flowing the fluid past the groove forms microvortices in the fluid.

In some embodiments, the adherent is an antibody.

In some embodiments, the adherent is an aptamer.

In some embodiments, the inlet is configured to receive the fluid that includes the analyte.

In some embodiments, the apex and the two ends form a V-shape.

In some embodiments, the groove spans less than a width of the micro-channel.

In some embodiments, each of the two ends are equidistant from the apex.

In some embodiments, the groove is formed symmetrically in the surface of the wall such that the apex is positioned on an axis passing through a center of the micro-channel and the two ends are equidistantly positioned from the apex.

In some embodiments, a first of the two ends is positioned nearer to the apex than a second of the two ends.

In some embodiments, the apex is offset from an axis extending along a center of the micro-channel.

In some embodiments, the groove is positioned such that a first end of the groove receives the fluid before a second end.

In some embodiments, the groove is one of a plurality of grooves defined in the wall of the micro-channel, each of the plurality of grooves having an apex and two ends.

In some embodiments, the plurality of grooves are disposed in a column of grooves.

In some embodiments, the device further comprises include an additional column of grooves formed adjacent the column of grooves.

In some embodiments, an apex and two ends of a groove in the column of grooves are aligned with an apex and two ends of a groove in the additional column of grooves on corresponding planes that are perpendicular to an axis passing through the micro-channel.

In some embodiments, the additional column of grooves is offset from the column of grooves.

In some embodiments, a dimension of a groove projecting outward of the micro-channel is in a range between 3 μ m and 70 μ m.

Particular implementations of the subject matter described in this specification can be implemented to realize one or more of the following advantages. The techniques described here can increase a potential for the passive manipulation and capture of particles suspended in a fluid, for example, cells suspended in a buffer solution, in a microfluidic environment. The grooves formed in the micro-channel of the microfluidic device can induce helical flows that generate microvortices in the fluid flowing through the channel. The microvortices can be exploited to enhance the transverse movement of particles flowing axially through the channel, towards channel walls,