outcomes, and thus the study of individual cell behavior may be performed by single-cell analysis.

SUMMARY

Electrophoretic separation devices and methods for using the same are provided. Aspects of embodiments of the present disclosure include a device that includes a polymeric separation medium having a plurality of microwells formed therein. The polymeric separation medium includes electromagnetic radiation-activatable functional groups that covalently bond to one or more sample components of interest in the separation medium upon application of electromagnetic radiation, wherein the electromagnetic radiation-activatable functional groups are co-polymerized with the polymeric separation medium, and wherein the microwells have a width of 100 μm or less and a depth of 100 μm or less.

In some embodiments, the device includes a solid support contacting a surface of the polymeric separation medium, where the device includes at least one channel through a portion of one or more of the polymeric separation medium and the solid support.

In some embodiments, the microwells are arranged as an array of microwells in the polymeric separation medium. In some embodiments, the microwells include an open end on the surface of the polymeric separation medium and an opposing closed end in the polymeric separation medium.

In some embodiments, the polymeric separation medium includes a central well having a plurality of microwells positioned on the periphery and in fluid communication with the central well. In some embodiments, each microwell includes an open end in fluid communication with the central well and an opposing closed end in the polymeric separation medium. In some embodiments, the microwells are arranged around substantially the entire periphery of the central well. In some embodiments, the device includes a solid support carrying the polymeric separation medium, where the device includes at least one channel through a portion of one or more of the polymeric separation medium and the solid support.

In some embodiments, the polymeric separation medium includes 100 or more microwells.

In some embodiments, the microwells are dimensioned to accommodate single cells.

In some embodiments, the open end of the microwell has a width greater than the closed end of the microwell.

In some embodiments, the applied stimulus is light.

Aspects of the present disclosure further include a method that includes contacting a sample with a polymeric separation medium as disclosed herein, applying an electric field to the polymeric separation medium in a manner sufficient to move at least some components of the sample from the microwell into the polymeric separation medium to produce separated sample components in the polymeric separation medium; and immobilizing the separated sample contents in the polymeric separation medium by applying electromagnetic radiation to the electromagnetic radiation-activatable functional groups. In some embodiments, the polymeric separation medium includes functional groups that covalently bond to one or more sample components of interest in the separation medium upon application of an applied stimulus.

In some embodiments, the sample includes cells and/or cellular components. In some embodiments, the method includes lysing the cells to produce the cellular components in the sample. In some embodiments, the method includes incubating the cells to produce the cellular components in the sample.

In some embodiments, the method includes immobilizing the separated sample components in the polymeric separation medium.

In some embodiments, the method includes detecting the separated sample components. In some embodiments, the detecting includes contacting the separated sample components with an analyte detection reagent. In some embodiments, the method includes contacting the separated sample components with a second analyte detection reagent.

In some embodiments, the method includes imaging the polymeric separation medium to produce an image of the separated cellular components.

Aspects of the present disclosure also include a kit. In some embodiments, the kit includes a device as disclosed herein, and a packaging containing the device.

BRIEF DESCRIPTION OF THE FIGURES

FIG. 1a shows an image and drawings of a single-cell Western (scWestern) blotting assay according to embodiments of the present disclosure.

FIG. 1b shows a process flow schematic where an open-gel scWestern blotting was performed as a 4 hr multi-stage assay that included: cell settling, chemical lysis with a modified RIPA buffer, PAGE (E: electric field), UV protein immobilization (hv: photon energy) onto a photoactive capture gel with tunable porosity (PACTgel), and diffusion driven antibody probing (e.g., primary and fluorescently labeled secondary antibody probes, 1° Ab and 2° Ab*), according to embodiments of the present disclosure.

THAT WHICH IS CLAIMED IS:

1. A device comprising:

a polymeric separation medium comprising a plurality of microwells formed therein, wherein the polymeric separation medium comprises electromagnetic radiation-activatable functional groups that covalently bond to one or more sample components of interest in the separation medium upon application of electromagnetic radiation, wherein the electromagnetic radiation-activatable functional groups are co-polymerized with the polymeric separation medium, and wherein the microwells have a width of 100 μm or less and a depth of 100 μm or less.

2. The device of Claim 1, further comprising a solid support contacting a surface of the polymeric separation medium, wherein the device comprises at least one channel through a portion of one or more of the polymeric separation medium and the solid support.

3. The device of Claim 1, wherein the microwells are arranged as an array of microwells in the polymeric separation medium.

4. The device of Claim 3, wherein the microwells comprise an open end on the surface of the polymeric separation medium and an opposing closed end in the polymeric separation medium.

5. The device of Claim 1, wherein the polymeric separation medium comprises a central well comprising a plurality of microwells positioned on the periphery and in fluid communication with the central well.

6. The device of Claim 5, wherein each microwell comprises an open end in fluid communication with the central well and an opposing closed end in the polymeric separation medium.

7. The device of Claim 5, wherein the microwells are arranged around substantially the entire periphery of the central well.

8. The device of any of the preceding claims, wherein the polymeric separation medium comprises 100 or more microwells.

9. The device of Claims 4 or 6, wherein the open end of the microwell has a width greater than the closed end of the microwell.

10. A method comprising:

contacting a sample with a polymeric separation medium of any of the preceding claims;

applying an electric field to the polymeric separation medium in a manner sufficient to move at least some components of the sample from the microwell into the polymeric separation medium to produce separated sample components in the polymeric separation medium; and

immobilizing the separated sample contents in the polymeric separation medium by applying electromagnetic radiation to the electromagnetic radiation-activatable functional groups.

11. The method of Claim 10, wherein the sample comprises cells and/or cellular components.

12. The method of Claim 11, further comprising lysing the cells to produce the cellular components in the sample.

13. The method of Claim 11, further comprising incubating the cells to produce the cellular components in the sample.

14. The method of any of Claims 10-13, further comprising detecting the separated sample components.

15. The method of Claim 14, wherein the detecting comprises contacting the separated sample components with an analyte detection reagent.

16. The method of Claim 15, further comprising contacting the separated sample components with a second analyte detection reagent.

17. The method of any of Claims 10-16, further comprising imaging the polymeric separation medium to produce an image of the separated sample components.

18. A kit comprising:
a device according to any of Claims 1 to 9; and
a packaging containing the device.