CLAIMS

1. A device for manipulating microdroplets using optically-mediated electrowetting, the device comprising:

- a first composite wall comprised of:
  - a first transparent substrate
  - a first transparent conductor layer on the substrate having a thickness in the range 70 to 250nm;
  - a photoactive layer activated by electromagnetic radiation in the wavelength range 400-1000nm on the conductor layer having a thickness in the range 300-1000nm and
  - a first dielectric layer on the photoactive layer having a thickness in the range 120 to 160nm;
- a second composite wall comprised of:
  - a second substrate;
  - a second conductor layer on the substrate having a thickness in the range 70 to 250nm and
  - a second dielectric layer on the conductor layer having a thickness in the range 120 to 160nm

in which exposed surfaces of the first and second dielectric layers include one or more spacers for holding the first and second walls apart by a predetermined amount to define a microfluidic space adapted to contain microdroplets;

- an A/C source connecting the first and second conductor layers to provide a voltage of between 10 to 50V across the first and second composite walls;
- at least one source of electromagnetic radiation having an energy higher than the bandgap of the photoactive layer adapted to impinge on the photoactive layer to induce corresponding ephemeral electrowetting locations on the surface of the first dielectric layer and

- a microprocessor for manipulating the points of impingement of the electromagnetic radiation on the photoactive layer so as to vary the disposition of the ephemeral electrowetting locations thereby creating at least one electrowetting pathway along which the microdroplets may be caused to move.

2. A device according to Claim 1 characterised in that the first and second composite walls further comprise first and second anti-fouling layers on respectively the first and second dielectric layers.

3. A device according to Claim 2 characterised in that the anti-fouling layer on the second dielectric layer is hydrophobic.

4. A device according to any preceding claim characterised in that the microfluidic space is further defined by a spacer attached to the first and second dielectric layers.

5. A device according to any preceding claim characterised in that the electrowetting pathway is comprised of a continuum of virtual electrowetting locations each subject to ephemeral electrowetting at some point during use of the device.

6. A device according to any preceding claim characterised in that the first and second walls are held apart by 2 to 8μm to define a microfluidic space.

7. A device according to any preceding claim characterised in that the source(s) of electromagnetic radiation comprise a pixellated array or light reflected from or transmitted through such an array.

8. A device according to any preceding claim characterised in that the electrowetting locations are crescent-shaped in the direction of travel of the microdroplets.

9. A device according to any preceding claim characterised by further comprising a photodetector to stimulate and detect fluorescence in the microdroplets located within or downstream of the device.

10. A device according to any preceding claim characterised by further comprising an upstream inlet to generate a medium comprised of an emulsion of aqueous microdroplets in an immiscible carrier fluid.

11. A device according to any preceding claim characterised by further comprising an upstream inlet to induce a flow of a medium comprised of an emulsion of aqueous microdroplets in an immiscible carrier fluid through the microfluidic space via an inlet into the microfluidic space.

12. A device according to any preceding claim characterised in that the first and second composite wall are first and second composite sheets which define the microfluidic space therebetween and form the periphery of a cartridge or chip.

13. A device according to Claim 12 characterised by further comprising a plurality of first electrowetting pathways running concomitantly to each other.

14. A device according to Claim 13 characterised by further comprising a plurality of second electrowetting pathways adapted to intersect with the first electrowetting pathways to create at least one microdroplet-coalescing location.

15. A device according to any preceding claim characterised by further comprising an upstream inlet for introducing into the microfluidic space microdroplets whose diameters are more than 20% greater than the width of the microfluidic space.

16. A device according to any preceding claim characterised in that the second composite wall further comprises a second photoactive layer and the source of electromagnetic radiation also impinges on the second photoactive layer to create a second pattern of ephemeral electrowetting locations which can also be varied.

17. A device according to any preceding claim where spacers are used to control the spacing between the first and second layer structures, and the physical shape of these spacers is used to aid the splitting, merging and elongation of the microdroplets in the device

18. A method for manipulating aqueous microdroplets characterised by the steps of (a) introducing an emulsion of the microdroplets in an immiscible carrier medium into a microfluidic space comprising:

- a first composite wall comprised of:
  - a first transparent substrate
  - a first transparent conductor layer on the substrate having a thickness in the range 70 to 250nm;

- a photoactive layer activated by electromagnetic radiation in the wavelength range 400-1000nm on the conductor layer having a thickness in the range 300-1000nm and
- a first dielectric layer on the photoactive layer having a thickness in the range 120 to 160nm;

- a second composite wall comprised of:
  - a second substrate;
  - a second conductor layer on the substrate having a thickness in the range 70 to 250nm and
  - a second dielectric layer on the conductor layer having a thickness in the range 120 to 160nm;

in which exposed surfaces of the first and second dielectric layers include one or more spacers for holding the first and second walls apart by a predetermined amount to define the microfluidic space adapted to contain microdroplets;

(b) applying a plurality of point sources of the electromagnetic radiation to the photoactive layer to induce a plurality of corresponding ephemeral electrowetting locations in the first dielectric layer and (c) moving a least one of the microdroplets in the emulsion along an electrowetting pathway created by the ephemeral electrowetting locations by varying the application of the point sources to the photoactive layer.