CLAIMS

1. An apparatus for drawing a fibre, the apparatus comprising,

a first outlet for dispensing a volume of a first polyionic polymer solution; and

a second outlet for dispensing a volume of a second oppositely charged polyionic polymer solution; said second outlet disposed adjacent to the first outlet such that the polymer solutions dispensed therefrom are capable of contacting each other to form a fused droplet comprising a polyelectrolyte complex interface separating the first polyionic and second polyionic polymer solutions;

wherein the fused droplet is arranged to move along a fibre drawing path under gravitational force in an opposing direction from the first and second outlets such that nascent fibre is drawn from the polyelectrolyte complex interface.

2. The apparatus of claim 1, further comprising,

a gas outlet disposed between the first and second outlets, wherein the gas outlet is configured to discharge a stream of gas directed at the fused droplet to initiate movement of the fused droplet along the fibre drawing path.

3. The apparatus of claim 1 or 2, further comprising,

one or more pumps configured to continuously dispense the first and second polyionic polymer solutions via the respective first and second outlets to form additional fused droplets;

wherein the additional fused droplets are arranged to move along the fibre drawing path under gravitational force to form additional fibres.

4. The apparatus of any one of claims 1 to 3, further comprising,

a rotatable collector member comprising a contact segment, said contact segment being configured to collect one or more fibres that are detachably coupled to the first and second outlets;

wherein the rotatable collector member is configured to rotate in a substantially horizontal plane such that the contact segment is arranged to collect the one or more fibres from the first and second outlets each time the contact segment passes in relation to the first and second outlets;

wherein the rotatable collector member is configured to collect and combine a plurality of fibres to form a fibre construct; and

optionally wherein the rotatable collector member is further configured to wind the fibre or fibre construct onto itself.

5. The apparatus of claim 4, further comprising,

an elongated guide member coupled to the rotatable collector member and arranged to be substantially aligned with the fibre drawing path, said elongated guide member configured to guide one or more fused droplets lengthwise along the elongated guide member.

6. The apparatus of any one of claims 1 to 5, further comprising,

a first tube comprising a plurality of first outlets defined along a longitudinal axis of the first tube for dispensing a volume of the first polyionic polymer solution,

a second tube disposed substantially parallel to the first tube, said second tube comprising a plurality of second outlets defined along a longitudinal axis of the second tube for dispensing a volume of the second polyionic polymer solution;

wherein each of the plurality of first outlets is arranged to be disposed adjacent to a second outlet from the plurality of second outlets such that the polymer solutions dispensed therefrom are capable of contacting each other to form a plurality of fused droplets.

7. The apparatus of any one of claims 1 to 6, further comprising,

the first and second outlets in the form of tapered tips;

wherein an adhesive substrate is disposed at apex regions of the tapered tips of the first and/or second outlets to facilitate coupling to a starting portion of the fibre; and

optionally comprising a tip member disposed between, or in close proximity to, the first and second outlets for coupling to the starting portion of the fibre; and

optionally wherein the adhesive substrate is disposed at an apex region of the tip member.

8. The apparatus of any one of claims 1 to 7, wherein the first and second polyionic polymers are selected from the following pairs of polycationic and polyanionic polymers consisting of chitosan-alginate, chitosan-heparin, poly(diallyldimethylammonium chloride)-poly(sodium 4-styrenesulfonate), chitosan-carboxymethylcellulose, water-soluble chitin-carboxymethylcellulose, chitosan-gellan and chitosan-poly(glutamic acid).

9. The apparatus of any one of claims 1 to 8,

wherein the first and/or second polyionic polymer solutions further comprise a biological material;

optionally wherein the biological material is arranged to be encapsulated in the fibre as the fibre is being drawn from the polyelectrolyte complex interface; and

optionally wherein the biological material is selected from the group consisting of drugs, proteins, DNA, RNA, cells, viruses, microparticles, nanoparticles, contrast agents, and combinations thereof.

10. The apparatus of any one of claims 1 to 9, further comprising,

a third outlet for dispensing a volume of a third polyionic polymer solution having an opposite charge to the second polyionic polymer solution;

wherein the third outlet is disposed adjacent to the second outlet such that the third polyionic polymer solution is capable of contacting the second

polyionic polymer solution to form a second polyelectrolyte complex interface in the fused droplet; and

wherein a combined nascent fibre is drawn from the two polyelectrolyte complex interfaces as the fused droplet is arranged to move along the fibre drawing path.

11. A method of drawing a fibre, the method comprising,

dispensing a volume of a first polyionic polymer solution from a first outlet;

dispensing a volume of a second oppositely charged polyionic polymer solution from a second outlet, said second outlet being disposed adjacent to the first outlet;

contacting the volume of the first polyionic polymer solution and the volume of the second polyionic polymer solution to form a fused droplet comprising a polyelectrolyte complex interface separating the first polyionic and second polyionic polymer solutions;

moving the fused droplet along a fibre drawing path under gravitational force in an opposing direction from the first and second outlets; and

drawing nascent fibre from the polyelectrolyte complex interface.

12. The method of claim 11, further comprising,

discharging a stream of gas from a gas outlet disposed between the first and second outlets, and

directing the stream of gas at the fused droplet to initiate movement of the fused droplet along the fibre drawing path.

13. The method of claim 11 or 12, further comprising,

continuously dispensing the first and second polyionic polymer solutions via the respective first and second outlets using one or more pumps to form additional fused droplets; and

moving the additional fused droplets along the fibre drawing path under gravitational force to form additional fibres.

14. The method of any one of claims 11 to 13, further comprising,

rotating a rotatable collector member in a substantially horizontal plane;

collecting one or more fibres that are detachably coupled to the first and second outlets using a contact segment of the rotatable collector member each time the contact segment passes in relation to the first and second outlets;

combining a plurality of fibres to form a fibre construct;

optionally winding the fibre or fibre construct about the rotatable collector member; and

optionally guiding one or more fused droplets lengthwise along an elongated guide member coupled to the rotatable collector member and arranged to be substantially aligned with the fibre drawing path.

15. The method of any one of claims 11 to 14, further comprising,

dispensing a volume of the first polyionic polymer solution from a plurality of first outlets defined along a longitudinal axis of a first tube;

dispensing a volume of the second polyionic polymer solution from a plurality of second outlets defined along a longitudinal axis of the second tube, said second tube disposed substantially parallel to the first tube;

contacting the volume of the first polyionic polymer solution dispensed from each of the plurality of first outlets with the volume of the second polyionic polymer solution from each of the plurality of second outlets to form a plurality of fused droplets.

16. The method of any one of claims 11 to 15, further comprising,

providing the first and second outlets in the form of tapered tips;

providing an adhesive substrate disposed at apex regions of the tapered tips of the first and/or second outlets to facilitate coupling to a starting portion of the fibre; and

optionally providing a tip member disposed between, or in close proximity to, the first and second outlets; and

optionally providing the adhesive substrate disposed at an apex region of the tip member.

17. The method of any one of claims 11 to 16, wherein the first and second polyionic polymers are selected from the following pairs of polycationic and polyanionic polymers consisting of chitosan-alginate, chitosan-heparin, poly(diallyldimethylammonium chloride)-poly(sodium 4-styrenesulfonate), chitosan-carboxymethylcellulose, water-soluble chitin-carboxymethylcellulose, chitosan-gellan and chitosan-poly(glutamic acid).

18. The method of any one of claims 11 to 17, wherein the first and/or second polyionic polymer solutions further comprise a biological material;

optionally wherein the biological material is encapsulated in the fibre as the fibre is being drawn from the polyelectrolyte complex interface;

and optionally wherein the biological material is selected from the group consisting of drugs, proteins, DNA, RNA, cells, viruses, microparticles, nanoparticles, contrast agents, and combinations thereof.

19. The method of any one of claims 11 to 18, further comprising,

dispensing a volume of a third polyionic polymer solution from a third outlet disposed adjacent to the second outlet, said third polyionic polymer solution having an opposite charge to the second polyionic polymer solution and;

contacting the volume of the third polyionic polymer solution and the volume of the second polyionic polymer solution to form a second polyelectrolyte complex interface in the fused droplet; and

drawing a combined nascent fibre from the two polyelectrolyte complex interfaces as the fused droplet is moving along the fibre drawing path.

20. An apparatus for drawing a fibre, the apparatus comprising,

two or more outlets, each outlet configured for dispensing a volume of a polyionic polymer solution,

wherein the two or more outlets are arranged such that the polyionic polymer solutions dispensed therefrom are capable of contacting each other to form a fused droplet comprising at least one polyelectrolyte complex interface, each of the at least one polyelectrolyte complex interface separating two volumes of oppositely charged polyionic polymer solutions; and

wherein the fused droplet is arranged to move along a fibre drawing path under gravitational force in an opposing direction from the two or more outlets such that nascent fibre is drawn from the at least one polyelectrolyte complex interface.