CLAIMS:

1. A continuous flow process for controlled synthesis of a conducting polymer or salt thereof, comprising providing an emulsion of a polymerizable organic monomer and a free radical initiator in a temperature controlled continuous flow reactor comprising at least one mixing element, at a temperature effective for synthesising the conducting polymer or salt thereof to provide a product stream comprising the conducting polymer or salt thereof, wherein the emulsion is formed from an organic stream comprising the polymerizable organic monomer.

2. The continuous flow process of claim 1, wherein the emulsion comprises either i) the polymerizable organic monomer, a protonic acid, and the free radical initiator, or ii) an organic monomer salt of an organic monomer and a protonic acid, and the free radical initiator.

3. The continuous flow process of claim 1~~ or claim 2~~, wherein the organic stream further comprises a protonic acid.

4. The continuous flow process of any one of claims 1~~ to 3~~, wherein the emulsion is formed from the organic stream and an aqueous oxidant stream comprising the free radical initiator.

5. The continuous flow process of ~~any one of~~ claim~~s~~ 1~~ to 4~~, wherein the emulsion is formed from an organic stream and an oxidant stream, the organic stream comprising the polymerizable organic monomer and the protonic acid and the oxidant stream comprising the free radical initiator.

6. The continuous flow process of ~~any one of~~ claim~~s~~ 1~~ to 5~~, wherein the emulsion is formed from an organic stream comprising the polymerizable organic monomer and optionally a protonic acid and an oxidant stream comprising the free radical initiator, by:

i) introducing the oxidant stream into the organic stream in a fluid conduit or continuous flow reactor in proximate fluidic connection with the temperature controlled continuous flow reactor; or

ii) introducing the oxidant stream into the organic stream directly within the temperature controlled continuous flow reactor.

7. The continuous flow process of claim 6, wherein at least one of the oxidant stream and organic stream is cooled prior to introduction to one another.

8. The continuous flow process of ~~any one of~~ claim~~s~~ 1~~ to 7~~, wherein the temperature controlled continuous flow reactor is a temperature controlled continuous flow tubular reactor.

9. The continuous flow process of ~~any one of~~ claim~~s~~ 1~~ to 8~~, wherein the temperature of the emulsion in the reactor is controlled to between about -5 to 5°C. and maintained across an axial flow length of the continuous flow reactor with a variation of 3 degrees Celsius or less.

10. The continuous flow process of ~~any one of~~ claim~~s~~ 1~~ to 9~~, comprising:

a) providing an organic stream comprising an organic solvent, a polymerizable organic monomer and a protonic acid;

b) providing an oxidant stream comprising an aqueous solvent and a free radical initiator; ~~and~~

c) mixing the organic stream and oxidant stream to form an emulsion stream;

d) providing the emulsion stream in a temperature controlled continuous flow reactor comprising at least one mixing element, at a temperature effective for synthesising the conducting polymer or salt thereof to provide a product stream in the temperature controlled continuous flow comprising the conducting polymer or salt thereof; and

e) obtaining the conducting polymer or salt thereof from the product stream under continuous flow conditions, after the product stream has exited the temperature controlled continuous flow reactor.

11. The continuous flow process of ~~any one of~~ claim~~s~~ 1~~ to 10~~, wherein the conducting polymer is selected from the group consisting of a polyarylamine, polyarylthiol, polypyrrole, polycarbazole, polyindole, polyazepine, polythiophene, poly(3,4-ethylenedioxythiophene), poly(3,4-propylenedioxythiophene), ~~or~~ any salt thereof, and mixtures thereof, and the polymerizable organic monomer is selected from the group consisting of an arylamine, arylthiol, pyrrole, carbazole, indole, azepine, thiophene, 3,4-ethylenedioxythiophene, 3,4-propylenedioxythiophene monomer, ~~or~~ any salt thereof, and mixtures thereof and wherein each conducting polymer and polymerizable organic monomer is unsubstituted or substituted.

12. The continuous flow process of claim 11, wherein:
the conducting polymer is polyaniline and the polymerizable organic monomer is an unsubstituted or substituted aniline,
the conducting polymer is poly(3,4-ethylenedioxythiophene) and the polymerizable organic monomer is an unsubstituted or substituted 3,4-ethylenedioxythiophene, or
the conducting polymer is poly(3,4-propylenedioxythiophene) and the polymerizable organic monomer is an unsubstituted or substituted 3,4-propylenedioxythiophene monomer.

13. The continuous flow process of ~~any one of~~ claim~~s~~ 1~~ to 12~~, wherein each individual polymerised chain of the conducting polymer is independently comprised of individual monomer units of between about 100 to 1500.

14. The continuous flow process of ~~any one of~~ claim~~s~~ 1~~ to 13~~, wherein the conducting polymer has a weight average molecular weight of between 10,000 and 120,000.

15. The continuous flow process of ~~any one of~~ claim~~s~~ 1 ~~to 14~~, wherein the emulsion is formed from an oxidant stream, and wherein the oxidant stream is an aqueous stream comprising ~~or consisting of~~ an aqueous solvent and the free radical initiator.

16. The continuous flow process of ~~any one of~~ claim~~s~~ 1 ~~to 15~~, wherein the emulsion is formed from an organic stream, wherein the organic stream is a non-aqueous organic solution comprising ~~or consisting of the~~an organic solvent, the polymerizable organic monomer and a protonic acid.

17. The continuous flow process of ~~any one of~~ claim~~s~~ 1 ~~to 16~~, wherein the emulsion is formed from an organic stream comprising the polymerizable organic monomer and an oxidant stream comprising the free radical initiator, and the organic stream and oxidant stream are premixed under continuous flow conditions before introducing into the temperature controlled continuous flow reactor.

18. The continuous flow process of ~~any one of~~ claim~~s~~ 1 ~~to 17~~, wherein the organic stream is formed ~~from~~by:

~~a1) providing a protonic acid stream comprising an organic solvent and a protonic acid;~~

~~a2) providing a monomer stream comprising an organic solvent and the polymerizable organic monomer; and~~

~~a3) mixing together the protonic acid stream and monomer stream to form the organic stream.~~ mixing together a protonic acid stream and a monomer stream to form the organic stream, the protonic acid stream comprising an organic solvent and a protonic acid, and the monomer stream comprising an organic solvent and the polymerizable organic monomer.

19. The continuous flow process of ~~any one of~~ claim~~s~~ 1 ~~to 18~~, ~~wherein the temperature controlled continuous flow reactor~~ wherein the one or more mixing elements comprises one or more static mixers.

20. The continuous flow process of claim 1, wherein the process provides at least about 50 g of conducting polymer per hour of operation.

21. The continuous flow process of claim 20, wherein the operation is with respect to a continuous flow reactor volume of about 100 to 3000 ml.

22. The continuous flow process of claim 1, wherein the process provides at least about 100 g of conducting polymer per hour of operation per litre of internal volume of the continuous flow reactor.

23. The continuous flow process of claim 1, wherein the continuous flow process is operated as a single pass process or the temperature controlled continuous flow reactor is a single pass reactor.

~~20.~~24. The continuous flow process ~~of any one of claims 1 to 19~~, comprising:

a) providing an organic stream comprising an organic solvent, an unsubstituted or substituted aniline or salt thereof, and optionally a protonic acid;

b) providing an aqueous stream comprising an aqueous solvent and a free radical initiator;

c) mixing the organic stream and aqueous stream to form an emulsion stream;

d) providing the emulsion stream in a temperature controlled continuous flow tubular reactor comprising at least one mixing element, at a temperature effective for synthesising polyaniline or salt thereof to provide a product stream

in the temperature controlled continuous flow tubular reactor comprising the conducting polymer of polyaniline or salt thereof; and

e) obtaining the conducting polymer of polyaniline or salt thereof from the product stream under continuous flow conditions, after the product stream has exited the temperature controlled continuous flow tubular reactor.

~~21.~~25. The continuous flow process of ~~any one of~~ claim~~s 1 to 20~~24, wherein the polymerizable organic monomer is an unsubstituted aniline.

~~22.~~26. The continuous flow process of ~~any one of~~ claim~~s 1 to 21~~24, wherein the protonic acid is ~~dinonylnapthalenesulfonic~~ dinonylnaphthalenesulfonic acid (DNNSA).

~~23.~~27. The continuous flow process of ~~any one of~~ claim~~s 1 to 22~~24, wherein the organic solvent is selected from the group consisting of aromatic hydrocarbon, aliphatic hydrocarbon, glycols, ethers, glycol ethers, and mixtures thereof.

~~24.~~28. The continuous flow process of claim ~~23~~27, wherein the organic solvent is an aromatic hydrocarbon.

~~25.~~29. The continuous flow process of ~~any one of~~ claim~~s 1 to 24~~24, wherein the free radical initiator is an oxidising agent selected from the group consisting of persulfates, peroxides, dichromates, cerium (IV) salts, and mixtures thereof.

~~26.~~30. The continuous flow process of ~~any one of~~ claim~~s 1 to 25~~24, wherein the free radical initiator is ammonium persulfate.

~~27.~~31. The continuous flow process of ~~any one~~ claim~~s 1 to 26~~24, wherein ~~the~~ a concentration of the polymerizable organic monomer in the organic stream is from about 0.1 M to about 0.8 M.

~~28.~~32. The continuous flow process of claim ~~27~~31, wherein the polymerizable organic monomer is aniline and the concentration of the aniline in the organic stream is from about 0.2 M to about 0.5 M.

~~29.~~33. The continuous flow process of ~~any one of~~ claim~~s 1 to 28~~24, wherein the continuous flow reactor is a continuous flow tubular reactor and the internal diameter of the tubular reactor is at least about 2 mm.

~~30. The continuous flow process of any one of claims 1 to 291, wherein the process provides at least about 50 g of conducting polymer per hour of operation.~~

~~31. The continuous flow process of claim 30, wherein the operation performance is with respect to a continuous flow reactor volume of about 100 to 3000 ml.~~

~~32. The continuous flow process of any one of claims 1 to 31, wherein the process provides at least about 100 g of conducting polymer per hour of operation per litre of internal volume of the continuous flow reactor.~~

~~33. The continuous flow process of any one of claims 1 to 32, wherein the continuous flow process is operated as a single pass process or the temperature controlled continuous flow reactor is a single pass reactor.~~

~~34. A conducting polymer prepared by the continuous flow process according to any one of claims 1 to 33.~~

~~35. A composition, coating or material comprising the conducting polymer or salt thereof of claim 34.~~

~~36. A system for providing a continuous flow process for controlled synthesis of a conducting polymer or salt thereof according to any one of claims 1 to 33, comprising:~~

a) a temperature controlled continuous flow reactor comprising at least one mixing element;

b) one or more pumps for providing fluidic flow for any one or more streams passing through the temperature controlled continuous flow reactor;

c) one or more heat exchangers for controlling the temperature of the temperature controlled continuous flow reactor;

d) a temperature control device cooperatively associated with the temperature controlled continuous flow reactor and the one or more heat exchangers for controlling the temperature of the streams in the temperature controlled continuous flow reactor effective for synthesising the conducting polymer or any salt thereof; and

e) a control means for controlling one or more of the parameters of the system selected from concentration, flow rate, temperature, pressure, and residence time, of one or more streams, fluidic reactants, sources of fluidic reactants, fluids, or products of the reaction.