Claims

1. A composition comprising branched polyethylenimine and polypropylene glycol covalently bonded to the branched polyethyleneimine, wherein a molar ratio of the propylene glycol to the branched polyethylenimine is more than 3.35:1, and the polypropylene glycol is hydrophobic, wherein the propylene glycol has a number average molecular weight from 1.5 kDa to 4 kDa, wherein the branched polyethylenimine has a weight average molecular weight from 15 kDa to 40 kDa, wherein the molar ratio of propylene glycol to polyethylenimine is from more than 3.35:1 to 60:1..

2. The composition according to claim 1, wherein a first end of the propylene glycol is capped with an aliphatic group, an aryl group, or an aralkyl group in any combinations thereof, and a second end of the propylene glycol is covalently bonded to the branched polyethylenimine.

3. The composition according to claim 2, wherein the propylene glycol is capped with the aliphatic group, preferably a C1 to C6 alkyl group.

4. The composition according to any one of claims 1 to 3, wherein the polypropylene glycol has a number average molecular weight from 2 kDa to 3 kDa.

5. The composition according to any one of claims 1 to 4, wherein the branched polyethylenimine has a weight average molecular weight from 20 kDa to 30 kDa.

6. The composition according to any one of claims 1 to 5, wherein the branched polyethylenimine has a degree of branching from 5% to 50%.

7. The composition according to any one of claims 1 to 6, wherein the polypropylene glycol is covalently bonded to the branched polyethyleneimine via a functional group selected from the group consisting of a carbamate, a carbonate, a carbamide, an ester, an amide, an ether, an amine, a triazole,

and any combinations thereof, preferably the carbamate, the amide, the ether, the amine, the triazole, and any combinations thereof.

8. The composition according to any one of claims 1 to 7, wherein the molar ratio of propylene glycol to polyethylenimine is from more than 3.35:1 to 50:1, preferably the molar ratio is from more than 3.35:1 to 40:1.

9. The composition according to claim 8, wherein the branched polyethylenimine is unquarternised, and the molar ratio of propylene glycol to branched polyethylenimine is from more than 3.35:1 to 40:1, preferably the molar ratio is from 7:1 to 35:1, more preferably the molar ratio is from 10:1 to 25:1.

10. The composition according to claim 9, wherein the molar ratio of propylene glycol to branched polyethylenimine is from 15:1 to 20:1, preferably the molar ratio is from 17:1 to 19:1.

11. The composition according to any one of claims 1 to 7, wherein the branched polyethylenimine comprises from 1 mol% to 50 mol% of nitrogen atoms quarternised with a second aryl group, a second aliphatic group, or a second aralkyl group in any combinations thereof, and the molar ratio of propylene glycol to polyethylenimine is more than 8.13:1, preferably the polyethylenimine comprises 1 mol% to 30 mol% of nitrogen atoms quarternised.

12. The composition according to claim 11, wherein the molar ratio of propylene glycol to branched polyethylenimine is from more than 8.13:1 to 60:1, preferably the molar ratio is from 15:1 to 60:1, more preferably the molar ratio is from 15:1 to 50:1, even more preferably the molar ratio is from 15:1 to 40:1.

13. The composition according to any one of claims 1 to 12, wherein the composition essentially excludes polyethylene glycol.

14. The composition according to any one of claims 1 to 13, further comprising a third polymer up to 20 weight percent of the composition, wherein the third polymer is different from polyethylenimine and polypropylene glycol.

15. The composition according to any one of claims 1 to 12, wherein the branched polyethylenimine and the polypropylene glycol are the only polymers present, preferably the composition consists essentially of branched polyethylenimine and polypropylene glycol.

16. The composition according to any one of claims 1 to 15 further comprising water, and preferably a buffer solution.

17. The composition according to claim 16, wherein the composition changes between a solution phase and a gel phase based on changes in the temperature and/or pH.

18. The composition according to claim 16 or claim 17 further comprising at least one of the following: a therapeutic agent, a protein, and a nucleic acid sequence.

19. Use of the composition according to any one of claims 1 to 17 in the capture of carbon dioxide.

20. Use of the composition according to any one of claims 1 to 17 in the recovery of a metal from waste.