CLAIMS

1. A polyacrylamide-based copolymer consisting of:

a water-soluble carrier monomer selected from *N*-(3-methoxypropyl)acrylamide (MPAM) and 4-acryloylmorpholine (MORPH); and

a functional dopant monomer that is *N*-isopropylacrylamide (NIP),

wherein NIP is 10% to 28% by weight of the copolymer.

2. A polyacrylamide-based copolymer comprising:

a water-soluble carrier monomer selected from *N*-(3-methoxypropyl)acrylamide (MPAM) and 4-acryloylmorpholine (MORPH); and

a functional dopant monomer that is *N*-phenylacrylamide (PHE).

3. The copolymer of claim 2, wherein the weight percent (wt%) of the water-soluble carrier monomer is 70% to 98%, 70% to 95%, 75% to 90%, or 74% to 80%.

4. The copolymer of claim 2, wherein the weight percent (wt%) of the functional dopant monomer is 2% to 30%, 5% to 30%, 5% to 26%, or 5% to 10%.

5. The copolymer of claim 1, wherein NIP is 20% to 26% by weight of the copolymer.

6. The copolymer of claim 5, wherein NIP is 22%, 23%, or 24% by weight of the copolymer.

7. The copolymer of any one of claims 1 to 6, wherein the water-soluble carrier monomer is MORPH.

8. The copolymer of any one of claims 1 to 6, wherein the water-soluble carrier monomer is MPAM.

9. The copolymer of any one of claims 1 to 6, wherein the copolymer consists of:

77% by weight of MORPH; and

23% by weight of NIP.

10. The copolymer of any one of claims 1 to 8, wherein the degree of polymerization of the copolymer is 10 to 500, 20 to 200, or 50, as determined by nuclear magnetic resonance (NMR) spectroscopy.

11. The copolymer of claim 10, wherein the degree of polymerization is 10 to 100, or 50 to 100, as determined by nuclear magnetic resonance (NMR) spectroscopy.

12. The copolymer of any one of claims 1 to 9, wherein the molecular weight of the copolymer is 1,000 to 40,000 g/mol, 1,000 to 30,000 g/mol, 2,000 to 10,000 g/mol, 3,000 to 7,000 g/mol, or 4,000 to 6,000 g/mol, as determined by size exclusion chromatography (SEC).

13. The copolymer of claim 12, wherein the molecular weight of the copolymer is from 3,000 to 15,000 g/mol, 4,000 g/mol to 10,000 g/mol, or 4,000 g/mol to 7,000 g/mol, as determined by size exclusion chromatography (SEC).

14. A polyacrylamide-based copolymer comprising:

a water-soluble carrier monomer selected from N-(3-methoxypropyl)acrylamide (MPAM), 4-acryloylmorpholine (MORPH), N,N-dimethylacrylamide (DMA), N-hydroxyethyl acrylamide (HEAM), and acrylamide (AM); and

a functional dopant monomer selected from *N*-[tris(hydroxymethyl)-methyl]acrylamide (TRI), 2-acrylamido-2-methylpropane sulfonic acid (AMP), (3-acrylamidopropyl)trimethylammonium chloride (TMA), *N*-isopropylacrylamide (NIP), *N*-*tert*-butylacrylamide (TBA), and *N*-phenylacrylamide (PHE); wherein:

a weight percent (wt%) of the water-soluble carrier monomer is 70% to 98%;

the weight percent (wt%) of the functional dopant monomer is 2% to 30%;

the average molecular weight (Mn) of the polyacrylamide-based copolymer is 3,000 g/mol to 15,000 g/mol, as determined by size exclusion chromatography (SEC); and

a degree of polymerization is 10 to 250, as determined by nuclear magnetic resonance (NMR) spectroscopy.

15. The copolymer of claim 14, wherein the weight percent (wt%) of the water-soluble carrier monomer is 70% to 95%, 75% to 90%, or 74% to 80%.

16. The copolymer of claim 14, wherein the weight percent (wt%) of the functional dopant monomer is 5% to 30%, 5% to 26%, or 5% to 10%.

17. The copolymer of any one of claims 14 to 16, wherein the water-soluble carrier monomer is MPAM.

18. The copolymer of any one of claims 14 to 16, wherein the water-soluble carrier monomer is MORPH.

19. The copolymer of any one of claims 14 to 16, wherein the water-soluble carrier monomer is DMA.

20. The copolymer of any one of claims 14 to 16, wherein the water-soluble carrier monomer is HEAM.

21. The copolymer of any one of claims 14 to 16, wherein the water-soluble carrier monomer is AM.

22. The copolymer of any one of claims 14 to 21, wherein the functional dopant monomer is TRI.

23. The copolymer of any one of claims 14 to 21, wherein the functional dopant monomer is AMP.

24. The copolymer of any one of claims 14 to 21, wherein the functional dopant monomer is TMA.

25. The copolymer of any one of claims 14 to 21, wherein the functional dopant monomer is NIP.

26. The copolymer of any one of claims 14 to 21, wherein the functional dopant monomer is TBA.

27. The copolymer of any one of claims 14 to 21, wherein the functional dopant monomer is PHE.

28. The copolymer of any one of claims 14 to 27, wherein:

the degree of polymerization is from 20 to 200, as determined by nuclear magnetic resonance (NMR) spectroscopy; and

the average molecular weight (Mn) of the copolymer is from 2,000 to 10,000 g/mol, as determined by size exclusion chromatography (SEC).

29. The copolymer of any one of claims 14 to 27, wherein the degree of polymerization is 10 to 100, or 50 to 100, as determined by nuclear magnetic resonance (NMR) spectroscopy.

30. The copolymer of any one of claims 14 to 27, wherein the average molecular weight (Mn) of the copolymer is 4,000 g/mol to 10,000 g/mol, or 4,000 g/mol to 7,000 g/mol, as determined by size exclusion chromatography (SEC).

31. The copolymer of any one of claims 1 to 30, wherein the copolymer is a random copolymer.

32. A composition comprising the polyacrylamide-based copolymer of any one of claims 1 to 31, and a pharmaceutically acceptable excipient.

33. A composition comprising the copolymer of any one of claims 1 to 31, wherein the composition is a cosmetic product, a hair product, a lotion, a food product, a veterinary product, or a nutritional product.

34. A composition comprising the copolymer of any one of claims 1 to 31, and a protein.

35. The composition of claim 34, wherein the protein is susceptible to aggregation in an aqueous medium.

36. The composition of claim 34 or 35, wherein the protein is selected from antibodies and fragments thereof, cytokines, chemokines, hormones, vaccine antigens, cancer antigens, adjuvants, and combinations thereof.

37. The composition of claim 36, wherein the protein is a monoclonal antibody.

38. The composition of claim 36, wherein the protein is insulin, or an analog thereof.

39. A method for increasing stability of a protein formulation, comprising adding 0.005 wt% to 5 wt% of the copolymer of any one of claims 1 to 31 to the protein formulation.

40. A method for reducing the rate of aggregation of a protein in an aqueous composition, comprising adding 0.005 wt% to 5 wt% of the copolymer of any one of claims 1 to 31 to the protein formulation.