Claims:

1. A continuous process for producing a halogenated isoolefin copolymer, the process comprising:

(a) polymerizing at least one isoolefin monomer and at least one copolymerizable unsaturated monomer in an organic diluent to produce a halogenatable isoolefin copolymer in an organic medium;

(b) contacting the organic medium with an aqueous medium comprising an anti-agglomerant comprising a lower critical solution temperature (LCST) compound;

(c) removing or partially removing the organic diluent to produce an aqueous slurry comprising particles of the halogenatable isoolefin copolymer;

(d) dissolving the aqueous slurry in an organic solvent in a closed dissolving/separating apparatus to form an halogenatable isoolefin copolymer cement in water, and phase separating the water from the cement in the closed dissolving/separating apparatus;

(e) contacting the separated halogenatable isoolefin copolymer cement under halogenation conditions with a halogenating agent and an aqueous solution of a C_{1-20} organic peracid oxidant to form a two-phase reaction medium comprising an organic phase and an aqueous phase, the organic peracid oxidant capable of converting hydrogen halide to free halogen; and,

(f) recovering halogenated isoolefin copolymer containing at least 0.05 mol% of chemically combined halogen.

2. The process of claim 1, wherein the at least one isoolefin monomer is isobutylene and the at least one copolymerizable unsaturated monomer is isoprene or *p*-methyl styrene.

3. The process of claim 1 or claim 2, wherein the organic diluent comprises methyl chloride.

4. The process of any one of claims 1 to 3, wherein the LCST compound comprises poly(N-isopropylacrylamide), poly(N-isopropylacrylamide-co-N,N-dimethylacrylamide, poly(N-isopropylacrylamide)-alt-2-hydroxyethylmethacrylate, poly(N-vinylcaprolactam), poly(N,N-diethylacrylamide), poly[2-(dimethylamino)ethyl methacrylate], poly(2-oxazoline)

glycopolymers, poly(3-ethyl-N-vinyl-2-pyrrolidone), hydroxylbutyl chitosan, polyoxyethylene (20) sorbitan monostearate, polyoxyethylene (20) sorbitan monolaurate, polyoxyethylene (20) sorbitan monooleate, methyl cellulose, hydroxypropyl cellulose, hydroxyethyl methylcellulose, hydroxypropyl methylcellulose, poly(ethylene glycol) methacrylates with 2 to 6 ethylene glycol units, polyethyleneglycol-co-polypropylene glycols (preferably those with 2 to 8 ethylene glycol units and 2 to 8 polypropylene units, more preferably 2 to 6 ethylene glycol units and 2 to 6 polypropylene units), compounds of formula (I)

(I) $HO-[-CH_2-CH_2-O]_x-[-CH(CH_3)-CH_2-O]_y-[-CH_2-CH_2-O]_z-H$

with y = 3 to 10 and x and z = 1 to 8, whereby y+x+z is from 5 to 18,

ethoxylated iso-$C_{13}H_{27}$-alcohols, polyethylene glycol with 4 to 50 ethyleneglycol units, polypropylene glycol with 4 to 30 propyleneglycol units, polyethylene glycol monomethyl ether with 4 to 50 ethyleneglycol unit, polyethylene glycol dimethyl ether with 4 to 50 ethyleneglycol units, polyethylene glycol monoethyl ether with 4 to 50 ethyleneglycol units, polyethylene glycol diethyl ether with 4 to 50 ethyleneglycol units, polypropylene glycol monomethyl ether with 4 to 50 propyleneglycol units, polypropylene glycol dimethyl ether with 4 to 50 propyleneglycol units, polypropylene glycol monoethyl ether with 4 to 50 propyleneglycol units, diethyl ether with 4 to 50 propyleneglycol units, or any mixture thereof.

5. The process of any one of claims 1 to 4, wherein the organic solvent is a non-halogenated organic solvent.

6. The process of claim 5, wherein the non-halogenated organic solvent comprises hexanes, isopentane or a mixture thereof.

7. The process of any one of claims 1 to 6, wherein the closed dissolving/separating apparatus comprises:

a closed dissolving zone for receiving both the aqueous slurry and the organic solvent, the dissolving zone comprising a mixer for agitating the aqueous slurry and the organic solvent to dissolve the halogenatable isoolefin copolymer in the organic solvent to form the halogenatable isoolefin copolymer cement in water; and,

a closed separating zone in fluid communication with the dissolving zone, the separating zone being configured for phase separation of the halogenatable isoolefin copolymer cement from the water with formation of a water layer and a cement layer

~~separated by an interface layer, and the separating zone comprising a first outlet configured for output of the water layer from the separating zone, and a second outlet configured for output of the cement layer from the separating zone,~~

~~wherein the closed dissolving zone and the closed separating zone are in a single flow-through vessel with the closed dissolving zone disposed horizontally adjacent the closed separating zone, and wherein the apparatus is configured for lateral flow through the vessel from the closed dissolving zone through the closed separating zone.~~

~~8. The process of any one of claims 1 to 7, wherein the water content of the cement is 1-20 wt%, based on total weight of the cement.~~

~~9. The process of any one of claims 1 to 7, wherein the water content of the cement is 3 wt% or less, based on total weight of the cement.~~

~~10. The process of any one of claims 1 to 7, wherein the water content of the cement is 1.5-15 wt%, based on total weight of the cement.~~

~~11. The process of any one of claims 1 to 10, wherein the organic peracid is a C_{1-4} organic peracid.~~

~~12. The process of any one of claims 1 to 11, wherein the organic peracid is pre-made and dissolved directly into the aqueous solution.~~

~~13. The process of any one of claims 1 to 11, wherein the organic peracid is produced *in situ* in the aqueous solution by reacting an organic acid with a water-soluble oxidizing agent in the aqueous solution prior to contacting the halogenatable isoolefin copolymer cement with the aqueous solution.~~

~~14. The process of any one of claims 1 to 13, wherein halogenating the halogenatable isoolefin copolymer is performed in an absence of emulsifier.~~

~~15. The process of any one of claims 1 to 14, wherein the halogenating agent is Br_2.~~

~~16. The process of any one of claims 1 to 15, wherein the contacting the separated halogenatable isoolefin copolymer cement with the halogenating agent is conducted for 1-60 minutes at a temperature in a range of 20-60°C.~~

1. A continuous process for producing a halogenated isoolefin copolymer, the process comprising:

(a) polymerizing at least one isoolefin monomer and at least one copolymerizable

unsaturated monomer in an organic diluent to produce a halogenatable isoolefin copolymer in an organic medium;

(b) contacting the organic medium with an aqueous medium comprising an anti-agglomerant comprising a lower critical solution temperature (LCST) compound;

(c) removing or partially removing the organic diluent to produce an aqueous slurry comprising particles of the halogenatable isoolefin copolymer;

(d) dissolving the aqueous slurry in an organic solvent in a closed dissolving/separating apparatus to form an halogenatable isoolefin copolymer cement in water, and phase separating the water from the cement in the closed dissolving/separating apparatus;

(e) contacting the separated halogenatable isoolefin copolymer cement under halogenation conditions with a halogenating agent and an aqueous solution of a C_{1-20} organic peracid oxidant to form a two-phase reaction medium comprising an organic phase and an aqueous phase, the organic peracid oxidant capable of converting hydrogen halide to free halogen; and,

(f) recovering halogenated isoolefin copolymer containing at least 0.05 mol% of chemically combined halogen.

2. The process of claim 1, wherein the at least one isoolefin monomer is isobutylene and the at least one copolymerizable unsaturated monomer is isoprene or p-methyl styrene.

3. The process of claim 1, wherein the organic diluent comprises methyl chloride.

4. The process of claim 1, wherein the LCST compound comprises poly(N-isopropylacrylamide), poly(N-isopropylacrylamide-co-N,N-dimethylacrylamide, poly(N-isopropylacrylamide)-alt-2-hydroxyethylmethacrylate, poly(N-vinylcaprolactam), poly(N,N-diethylacrylamide), poly[2-(dimethylamino)ethyl methacrylate], poly(2-oxazoline) glycopolymers, poly(3-ethyl-N-vinyl-2-pyrrolidone), hydroxylbutyl chitosan, polyoxyethylene (20) sorbitan monostearate, polyoxyethylene (20) sorbitan monolaurate, polyoxyethylene (20) sorbitan monooleate, methyl cellulose, hydroxypropyl cellulose, hydroxyethyl methylcellulose, hydroxypropyl methylcellulose, poly(ethylene glycol) methacrylates with 2 to 6 ethylene glycol units, polyethyleneglycol-co-polypropylene glycols compounds of formula (I)

(I) $HO\text{-}[\text{-}CH_2\text{-}CH_2\text{-}O]_x\text{-}[\text{-}CH(CH_3)\text{-}CH_2\text{-}O]_y\text{-}[\text{-}CH_2\text{-}CH_2\text{-}O]_z\text{-}H$

with y = 3 to 10 and x and z = 1 to 8, whereby y+x+z is from 5 to 18, ethoxylated iso-$C_{13}H_{27}$-alcohols, polyethylene glycol with 4 to 50 ethyleneglycol units,

polypropylene glycol with 4 to 30 propyleneglycol units, polyethylene glycol monomethyl ether with 4 to 50 ethyleneglycol unit, polyethylene glycol dimethyl ether with 4 to 50 ethyleneglycol units, polyethylene glycol monoethyl ether with 4 to 50 ethyleneglycol units, polyethylene glycol diethyl ether with 4 to 50 ethyleneglycol units, polypropylene glycol monomethyl ether with 4 to 50 propyleneglycol units, polypropylene glycol dimethyl ether with 4 to 50 propyleneglycol units, polypropylene glycol monoethyl ether with 4 to 50 propyleneglycol units, diethyl ether with 4 to 50 propyleneglycol units, or any mixture thereof.

5. The process of claim 1, wherein the organic solvent is a non-halogenated organic solvent.

6. The process of claim 5, wherein the non-halogenated organic solvent comprises hexanes, isopentane or a mixture thereof.

7. The process of claim 1, wherein the closed dissolving/separating apparatus comprises:

a closed dissolving zone for receiving both the aqueous slurry and the organic solvent, the dissolving zone comprising a mixer for agitating the aqueous slurry and the organic solvent to dissolve the halogenatable isoolefin copolymer in the organic solvent to form the halogenatable isoolefin copolymer cement in water; and,

a closed separating zone in fluid communication with the dissolving zone, the separating zone being configured for phase separation of the halogenatable isoolefin copolymer cement from the water with formation of a water layer and a cement layer separated by an interface layer, and the separating zone comprising a first outlet configured for output of the water layer from the separating zone, and a second outlet configured for output of the cement layer from the separating zone,

wherein the closed dissolving zone and the closed separating zone are in a single flow-through vessel with the closed dissolving zone disposed horizontally adjacent the closed separating zone, and wherein the apparatus is configured for lateral flow through the vessel from the closed dissolving zone through the closed separating zone.

8. The process of claim 1, wherein the water content of the cement is 1-20 wt%, based on total weight of the cement.

9. The process of claim 1, wherein the water content of the cement is 3 wt% or less, based on total weight of the cement.

10. The process of claim 7, wherein the water content of the cement is 1.5-15 wt%, based on total weight of the cement.

11. The process of claim 1, wherein the organic peracid oxidant is a C_{1-4} organic peracid.

12. The process of claim 1, wherein the organic peracid oxidant is pre-made and dissolved directly into the aqueous solution.

13. The process of claim 1, wherein the organic peracid oxidant is produced in situ in the aqueous solution by reacting an organic acid with a water-soluble oxidizing agent in the aqueous solution prior to contacting the halogenatable isoolefin copolymer cement with the aqueous solution.

14. The process of claim 1, wherein halogenating the halogenatable isoolefin copolymer is performed in an absence of emulsifier.

15. The process of claim 1, wherein the halogenating agent is Br_2.

16. The process of claim 1, wherein the contacting the separated halogenatable isoolefin copolymer cement with the halogenating agent is conducted for 1-60 minutes at a temperature in a range of 20-60°C.

17. The process of claim 1, wherein

the at least one isoolefin monomer is isobutylene and the at least one copolymerizable unsaturated monomer is isoprene or *p*-methyl styrene;

the organic diluent comprises methyl chloride;

the organic solvent is a non-halogenated organic solvent;

the water content of the cement is 1.5-15 wt%, based on total weight of the cement; and

the organic peracid oxidant is a C_{1-4} organic peracid;

18. The process of claim 17, wherein

the non-halogenated organic solvent comprises hexanes, isopentane or a mixture thereof;

the water content of the cement is 1.5 to 3 wt%, based on total weight of the cement;

halogenating the halogenatable isoolefin copolymer is performed in an absence of emulsifier; and

the halogenating agent is Br_2.

19. The process of claim 18, wherein the LCST compound comprises poly(N-isopropylacrylamide), poly(N-isopropylacrylamide-co-N,N-dimethylacrylamide, poly(N-isopropylacrylamide)-alt-2-hydroxyethylmethacrylate, poly(N-vinylcaprolactam), poly(N,N-diethylacrylamide), poly[2-(dimethylamino)ethyl methacrylate], poly(2-oxazoline) glycopolymers, poly(3-ethyl-N-vinyl-2-pyrrolidone), hydroxylbutyl chitosan, polyoxyethylene (20) sorbitan monostearate, polyoxyethylene (20) sorbitan monolaurate, polyoxyethylene (20) sorbitan monooleate, methyl cellulose, hydroxypropyl cellulose, hydroxyethyl methylcellulose, hydroxypropyl methylcellulose, poly(ethylene glycol) methacrylates with 2 to 6 ethylene glycol units, polyethyleneglycol-co-polypropylene glycols, compounds of formula (I)

(I) $HO\text{-}[\text{-}CH_2\text{-}CH_2\text{-}O]_x\text{-}[\text{-}CH(CH_3)\text{-}CH_2\text{-}O]_y\text{-}[\text{-}CH_2\text{-}CH_2\text{-}O]_z\text{-}H$

with y = 3 to 10 and x and z = 1 to 8, whereby y+x+z is from 5 to 18,

ethoxylated iso-$C_{13}H_{27}$-alcohols, polyethylene glycol with 4 to 50 ethyleneglycol units, polypropylene glycol with 4 to 30 propyleneglycol units, polyethylene glycol monomethyl ether with 4 to 50 ethyleneglycol unit, polyethylene glycol dimethyl ether with 4 to 50 ethyleneglycol units, polyethylene glycol monoethyl ether with 4 to 50 ethyleneglycol units, polyethylene glycol diethyl ether with 4 to 50 ethyleneglycol units, polypropylene glycol monomethyl ether with 4 to 50 propyleneglycol units, polypropylene glycol dimethyl ether with 4 to 50 propyleneglycol units, polypropylene glycol monoethyl ether with 4 to 50 propyleneglycol units, diethyl ether with 4 to 50 propyleneglycol units, or any mixture thereof;

wherein the contacting the separated halogenatable isoolefin copolymer cement with the halogenating agent is conducted for 1-60 minutes at a temperature in a range of 20-60 °C;

and wherein the closed dissolving/separating apparatus comprises:

a closed dissolving zone for receiving both the aqueous slurry and the organic solvent, the dissolving zone comprising a mixer for agitating the aqueous slurry and the organic solvent to dissolve the halogenatable isoolefin copolymer in the organic solvent to form the halogenatable isoolefin copolymer cement in water; and,

a closed separating zone in fluid communication with the dissolving zone, the separating zone being configured for phase separation of the halogenatable isoolefin copolymer cement from the water with formation of a water layer and a cement layer separated by an interface layer, and the separating zone comprising a first outlet configured

for output of the water layer from the separating zone, and a second outlet configured for output of the cement layer from the separating zone,

wherein the closed dissolving zone and the closed separating zone are in a single flow-through vessel with the closed dissolving zone disposed horizontally adjacent the closed separating zone, and wherein the apparatus is configured for lateral flow through the vessel from the closed dissolving zone through the closed separating zone.

20. A composition comprising the halogenated isoolefin copolymer prepared by the method of claim 1, and the organic peracid oxidant.