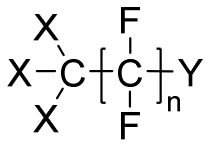
We claim:

1. A method for making a halogenated perfluoroaliphatic compound, comprising:

exposing a fluorine-containing compound having a structure according to Formula I to a halogen-based reagent at a reaction temperature ranging from 100 °C to 750 °C to provide a reaction mixture; and

isolating the halogenated perfluoroaliphatic compound from the reaction mixture; wherein Formula I is



Formula I

wherein

each X independently is selected from H, F, Br, or -CH_2OH;

n is an integer selected from 1 to 25; and

Y is selected from

H, -C(O)OH, -SO_3H, -SH; or

-C(O)R or -$[CH_2]_mOR$, wherein R is hydrogen, aliphatic, or cycloaliphatic, and m is an integer selected from 1 to 10; or

-$[CH_2]NR^aR^b$, wherein each of R^a and R^b independently is selected from hydrogen, aliphatic, heteroaliphatic, haloaliphatic, aromatic, or an organic functional group; or

-C(O)OR', C(O)OC(O)R', -$[CH_2]_mO$-$[CH_2]_mR'$ or -S-SR', wherein R' is a haloaliphatic group and m is an integer selected from 1 to 10; provided that (i) if Y is -$[CH_2]_mOR$, wherein R is H and m is 1; (ii) n is 3; and (iii) two X groups are F and one X group is H, then the halogen-based reagent is not Cl_2.

2. The method of claim 1, wherein the reaction temperature ranges from 150 °C to 650 °C, optionally wherein the reaction temperature ranges from 450 °C to 600 °C.

3. The method of claim 1 or claim 2, further comprising exposing the fluorine-containing compound, the halogen-based reagent, or both, to an inert gas, optionally wherein the inert gas is N_2 and the halogen-based reagent is Br_2, IBr, ICl, BrCl, or Cl_2.

4. The method of any one of claims 1-3, wherein isolating the halogenated perfluoroaliphatic compound from the reaction mixture comprises condensing the reaction mixture to provide a liquid reaction product mixture.

5. The method of claim 4, wherein condensing the reaction mixture comprises passing the reaction mixture through one or more condensing columns.

6. The method of claim 5, wherein the halogenated perfluoroaliphatic compound is obtained in a reaction fraction obtained from passing the reaction mixture through the one or more condensing columns and wherein the reaction fraction is subjected to a work-up procedure, a separation procedure, a purification procedure, or any combination thereof.

7. The method of any one of claims 1-6, wherein the method further comprises:

(i) converting the halogenated perfluoroaliphatic compound to a fluorotelomer; or

(ii) converting the halogenated perfluoroaliphatic compound to 1,3-hexafluorobutadiene.

8. The method of any one of claims 1-7, wherein:

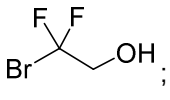
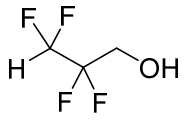
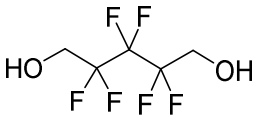
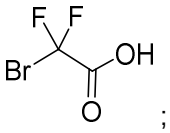
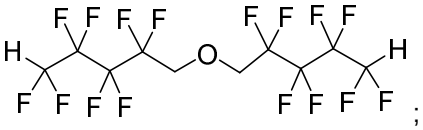
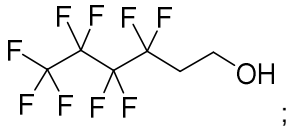
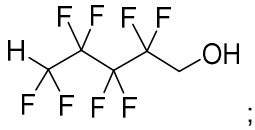
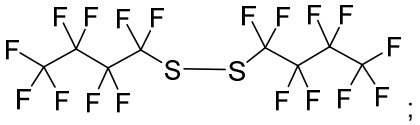
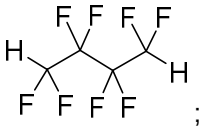
(i) R is selected from hydrogen, alkyl, alkenyl, alkynyl, cycloalkyl, cycloalkenyl, or cycloalkynyl;

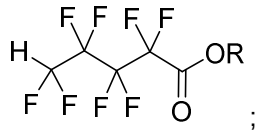
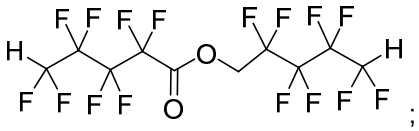
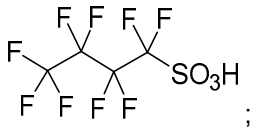
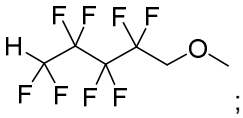
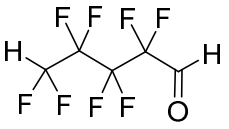
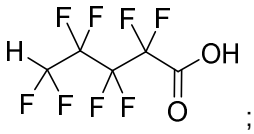
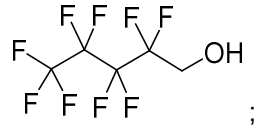
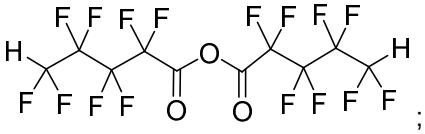
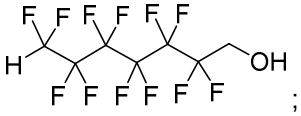
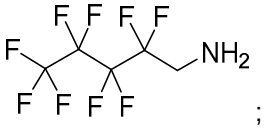
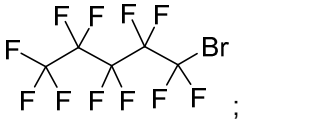
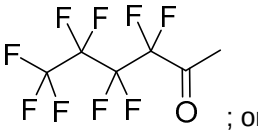
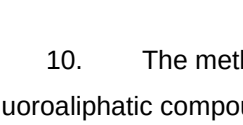
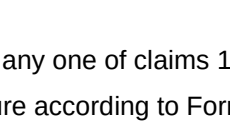
(ii) each of R^a and R^b independently is selected from hydrogen, alkyl, alkenyl, alkynyl, cycloalkyl, cycloalkenyl, cycloalkynyl, heteroalkyl, heteroalkenyl, heteroalkynyl, cycloheteroalkyl, cycloheteroalkenyl, cycloheteroalkynyl, haloalkyl, haloalkenyl, haloalkynyl, cyclohaloalkyl, cyclohaloalkenyl, cyclohaloalkynyl, or an organic functional group;

(iii) R' is selected from haloalkyl, haloalkenyl, haloalkynyl, cyclohaloalkyl, cyclohaloalkenyl, or cyclohaloalkynyl; and

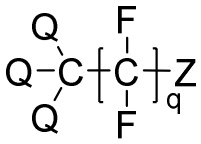
(iv) Y is selected from H, -C(O)Me, $-[CH_2]_{1\text{-}10}OH$, $-[CH_2]_{1\text{-}10}OMe$, -C(O)OH, -C(O)H, $-[CH_2]_{1\text{-}10}NH_2$, $-SO_3H$, -SH, $-C(O)O[CF_2]_{1\text{-}10}CF_2H$, $-C(O)OC(O)[CF_2]_{1\text{-}10}CF_2H$, $-[CH_2]_mO[CH_2]_m[CF_2]_{1\text{-}10}CF_2H$, or $-S\text{-}S[CF_2]_{1\text{-}10}CF_2H$.

9. The method of any one of claims 1-8, wherein the fluorine-containing compound is selected from


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10. The method according to any one of claims 1-9, wherein the halogenated perfluoroaliphatic compound has a structure according to Formula II



Formula II

wherein

each Q independently is Br, Cl, F, or H;

Z is selected from Br, -CF_2Br, Cl, -CF_2Cl, I, or -CF_2I; and

q is an integer selected from zero to 25; provided that the halogenated perfluoroaliphatic compound is not, or is other than, 1-chloro-1,1,2,2,3,3,4,4-octafluorobutane.

11. The method of any one of claims 1-10, wherein:

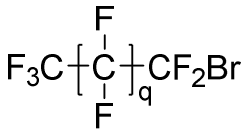
(i) each Q is F; Z is CF_2Br; and q is an integer ranging from zero to 18;

(ii) one Q is Br or H and the remaining two Q groups are F; Z is CF_2Br; and q is an integer ranging from zero to 18; or

(iii) one Q is Br and the remaining two Q groups are F; Z is Br; and q is zero.

12. The method of any one of claims 1-10, wherein:

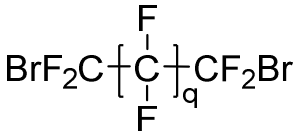
(i) the halogenated perfluoroaliphatic product has a structure according to Formula IIA'



Formula IIA'

wherein q is an integer selected from zero to 8;

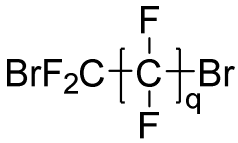
(ii) the halogenated perfluoroaliphatic compound has a structure according to Formula IIB'



Formula IIB'

wherein q is an integer selected from zero to 8; or

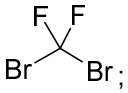
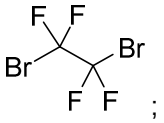
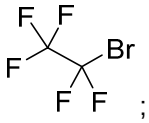
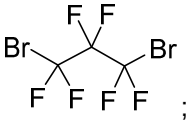
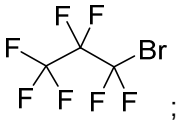
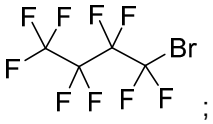
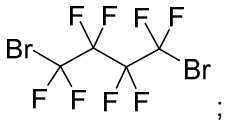
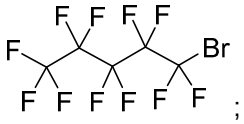
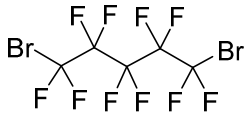
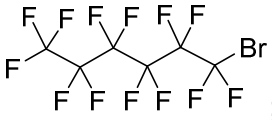
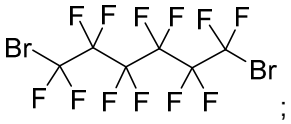
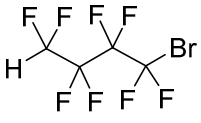
(iii) the halogenated perfluoroaliphatic compound has a structure according to Formula IIC'

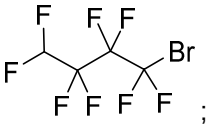
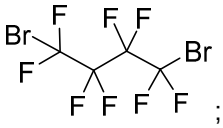
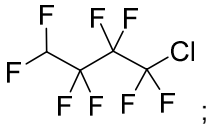
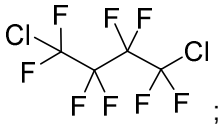
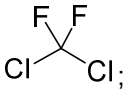
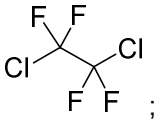
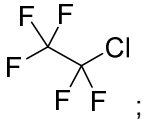
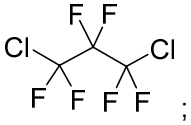
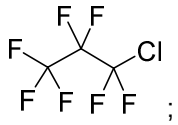
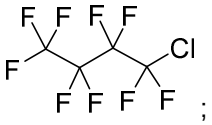
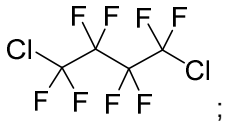
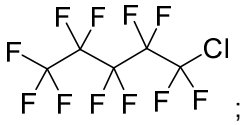
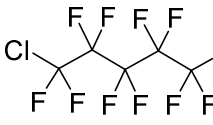
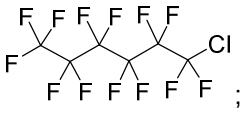
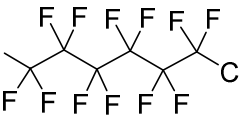


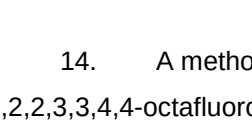
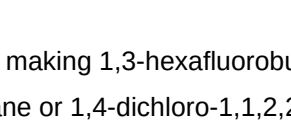
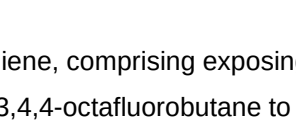
Formula IIC'

wherein q is zero.

13. The method of any one of claims 1-10, wherein the halogenated perfluoroaliphatic compound is selected from


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14. A method for making 1,3-hexafluorobutadiene, comprising exposing 1,4-dibromo-1,1,2,2,3,3,4,4-octafluorobutane or 1,4-dichloro-1,1,2,2,3,3,4,4-octafluorobutane to an alkyl magnesium compound, an aromatic magnesium compound, or alkyl lithium compound comprising an alkyl group comprising five or more carbon atoms.

15. The method of claim 14, wherein the alkyl lithium compound is *n*-hexyl lithium; or the alkyl magnesium compound is EtMgBr, BuMgBr, PrMgBr, EtMgCl, BuMgCl, PrMgCl, $(Me)_2Mg$, $(Et)_2Mg$, or $(Bu)_2Mg$; or the aromatic magnesium compound is PhMgBr.