CLAIMS

What is claimed is:

1. A process comprising:

   (a) contacting tetrachloroethylene (PCE) with HF and chlorine to form 1,1,2-trichloro-1,2,2-trifluoroethane (CFC-113),

   (b) contacting 1,1,2-trichloro-1,2,2-trifluoroethane (CFC-113) with a reducing metal in the liquid phase to form chlorotrifluoroethylene (CFO-1113),

   (c) contacting chlorotrifluoroethylene (CFO-1113) and hydrogen in one of the gas or liquid phase to form 1,1,2-trifluoroethane (HFC-143), and

   (d) converting 1,1,2-trifluoroethane (HFC-143) in the liquid or gas phase to form a mixture of E-1,2-difluoroethylene (HFO-E-1132) and Z-1,2-difluoroethylene (HFO-Z-1132).

2. The process of claim 1, further comprising **(e)** isomerizing a portion of the Z-1,2-difluoroethylene (HFO-Z-1132) in the mixture of E- and Z-1,2-difluoroethylene to E-1,2-difluoroethylene (HFO-E-1132).

3. The process of claim 1 or claim 2, wherein **(a)** comprises chlorofluorination of PCE to produce a first product mixture comprising the CFC-113, **(b)** comprises dechlorination of the CFC-113 to produce a second product mixture comprising the CFO-1113, **(c)** comprises hydrogenation of the CFO-1113 to produce a third product mixture comprising the HFC-143, and **(d)** comprises dehydrofluorination of the HFC-143 to produce a fourth product mixture comprising the HFO-E-1132 and HFO-Z-1132.

4. The process of claim 1 or claim 2, wherein PCE conversion is conducted in the presence of hydrogen fluoride and chlorine in one of: **(1)** the liquid phase catalyzed by a metal halide catalyst at temperatures between 80 and120°C, or **(2)** the gas phase in the presence of a chromium-based fluorination catalyst, and at temperatures between 250°C and 400°C.

5. The process of claim 1 or claim 2, wherein the PCE conversion produces a first product mixture comprising the CFC-113 and one or more additional compounds selected from the group consisting of 1,2-dichloro-1,1,2-

trifluoroethane (HCFC-123a), CFC-113a, CFC-114, CFC-114a, HCFC-124, and HCFC-123, and PCE.

6. The process of claim 1 or claim 2, wherein the reducing metal comprises zinc, magnesium, or cadmium in a solvent as the liquid phase.

7. The process of any one of claims 1, 2 or 6, wherein contacting 1,1,2-trichloro-1,2,2-trifluoroethane (CFC-113) with the reducing metal in the liquid phase is conducted at a temperature between about 20°C and about 120°C.

8. The process of claim 1 or claim 2, wherein contacting chlorotrifluoroethylene (CFO-1113) with hydrogen is conducted at a temperature between one of **(i)** 50°C to about 150°C and in the presence of a hydrogenation catalyst comprising a catalytic metal selected from the group consisting of Re, Ni, Pd, Pt, Ru, Rh, and Ir, or **(ii)** 150°C to about 350°C in the presence of a hydrogenation catalyst comprising a catalytic metal selected from the group consisting of Re, Ni, Pd, Pt, Ru, Rh, and Ir.

9. The process of claim 5, wherein the hydrogenation of chlorotrifluoroethylene (CFO-1113) produces a third product mixture which comprises primarily HFC-143 and one or more additional compounds selected from the group consisting of HFO-1123, HFC-134a, HFC-152a, HFC-236fa, HFO-Z-1132, HFO-E-1132, HCFO-E-1122a, HCFO-Z-1122a, HCFO-1140, HCFC-133b, HCFO-Z-1131, HCFO-E-1131, HCFC-151a, HCC-160, and CFC-113.

10. The process of claim 9, wherein the third product mixture is converted in the gas phase or the liquid phase to a fourth product mixture comprising E-1,2-difluoroethylene (HFO-E-1132) and Z-1,2-difluoroethylene (HFO-Z-1132).

11. The process of claim 1, wherein conversion of CFO-1113 to HFC-143 is conducted in the gas phase at a temperature between 150°C and 400°C, or wherein conversion of CFO-1113 to HFC-143 is conducted in the liquid phase at a temperature between -20°C and 150°C.

12. A composition comprising one of:

    (a) tetrachloroethylene (PCE) and at least one additional compound selected from the group consisting of CCl_4, $CHCl_3$, trichloroethylene, 1,1,3-trichloropropene, ethylene or 1,1,1,3-tetrachloropropane;

(b) 1,1,2-trichloro-1,2,2-trifluoroethane (CFC-113) and at least one additional compound selected from the group consisting of CFC-113a, CFC-114, CFC-114a, HCFC-124, HCFC-123, and PCE;

(c) chlorotrifluoroethylene (CFO-1113) and at least one additional compound selected from the group consisting of HCFC-123a, HCFC-133, HCFC-133a, HCFC-133b and CFC-113;

(d) 1,1,2-trifluoroethane (HFC-143) at least one additional compound selected from the group consisting of HFO-1123, CFO-1113, HFC-134, HFC-134a, HCFO-1131a, HCFC-142, HCFC-142a, HCFO-1122, HCFO-1122a, and HCO-1140;

(e) E-1,2-difluoroethylene (HFO-E-1132) and at least one additional compound selected from the group consisting of HFO-1141, HFO-1123, acetylene, HFO-Z-1132, HCFO-E-1131, HFC-125, HFC-32, HCFO-1131a, HCFO-Z-1122a, HCFO-E-1122a, HCFO-1122, and HCO-1140; or

(f) Z-1,2-difluoroethylene (HFO-Z-1132) and at least one additional compound selected from the group consisting of HFO-1141, HFO-1123, acetylene, HFC-134, HFO-E-1132, HCFO-E-1131, HCFO-1131a, HCFO-Z-1122a, HCFO-E-1122a, HCFO-1122, and HCO-1140.

13. A composition comprising at least one of:

(a) HFO-E-1132 and at least one additional compound selected from the group consisting of HFO-1141, HCFO-1140, acetylene and fluoroacetylene in an amount of <500 ppm,

(b) HFO-Z-1132 and at least one additional compound selected from the group consisting of HFO-1141, HCFO-1140, acetylene and fluoroacetylene in an amount of <500 ppm, or

(c) at least one of HFO-E-1132 and HFO-Z-1132, and at least two additional compounds selected from the group consisting of acetylene, fluoroacetylene, difluoromethane (HFC-32), 1,1,1,2,2 pentafluoroethane (HFC-125), E-1-chloro-1,2-difluoroethylene (HCFO-E-1122a), Z-1-chloro-1,2-difluoroethylene (HCFO-Z-1122a), 1,1,2-trifluoroethylene (HFO-1123), fluoroethylene (HFO-1141), 1-chloro-1,1,2-trifluoroethane

(HCFC-133), 1-chloro-1,1,2-trifluoroethane (HCFC-133b), 1,1-dichloro-2,2,2-trifluoroethane (HCFC-123), 1,2-difluoroethane (HFC-152), 1,1,2-trifluoroethane (HFC-143), fluoromethane (HFC-41), chlorodifluoromethane (HCFC-22), ethylene (HCO-1150), 1-chloro-1,2-difluoroethane (HCFC-142a), 1,1-difluoroethylene (HFO-1132a), vinyl chloride (1140), 1-chloro-1-fluoroethene (HCFO-E-1131a), E-1-chloro-2-fluoroethene (HCFO-E-1131), Z-1-chloro-2-fluoroethene (HCFO-Z-1131), and 1-chloro-2,2-difluoroethylene (HCFO-1122).

14. A composition comprising at least one of: HFO-E-1132 and HFO-Z-1132, and at least two additional compounds selected from the group consisting of acetylene, fluoroacetylene, difluoromethane (HFC-32), 1,1,1,2,2 pentafluoroethane (HFC-125), E-1-chloro-1,2-difluoroethylene (HCFO-E-1122a), Z-1-chloro-1,2-difluoroethylene (HCFO-Z-1122a), 1,1,2-trifluoroethylene (HFO-1123), fluoroethylene (HFO-1141), 1-chloro-1,1,2-trifluoroethane (HCFC-133), 1-chloro-1,1,2-trifluoroethane (HCFC-133b), 1,1-dichloro-2,2,2-trifluoroethane (HCFC-123), 1,2-difluoroethane (HFC-152), 1,1,2-trifluoroethane (HFC-143), fluoromethane (HFC-41), chlorodifluoromethane (HCFC-22), ethylene, 1-chloro-1,2-difluoroethane (HCFC-142a), 1,1-difluoroethylene (HFO-1132a), vinyl chloride (1140), 1-chloro-1-fluoroethene (HCFO-E-1131a), E-1-chloro-2-fluoroethene (HCFO-E-1131), Z-1-chloro-2-fluoroethene (HCFO-Z-1131), and 1-chloro-2,2-difluoroethylene (HCFO-1122), wherein the total amount of HFO-1141, HCFO-1140, acetylene and fluoroacetylene is selected from one of: <2000 ppm, <1000 ppm, <500 ppm,<2000 ppm, <1000 ppm, <500 ppm,400 ppm, <300 ppm, <200 ppm, <100 ppm, <50 ppm, <10 ppm, <5 ppm, or between ≥0.00001 ppm and <500 ppm, between ≥0.0001 ppm and <500 ppm, between ≥0.00001 ppm and <100 ppm, between ≥0.0001 ppm and <100 ppm, between ≥1 ppm and less than about 2000 ppm, between ≥1 ppm and less than about 1000 ppm, or ≥0 and <100 ppm and all values and ranges between about 0.00001 ppm and 2000 ppm.

15. The process of claim 1, further comprising isomerizing the HFO-E-1132 to HFO-Z-1132.

16. A system comprising:

a first reactor configured to synthesize a first mixture comprising 1,1,2-trichloro-1,2,2-trifluoroethane (CFC-113) from a feed compositon comprising tetrachloroethylene (PCE) and at least one additional compound selected from the group consisting of CCl_4, $CHCl_3$, trichloroethylene, 1,1,3-trichloropropene, ethylene and 1,1,1,3-tetrachloropropane;

a second reactor configured to convert the CFC-113 of the first mixture to a second mixture comprising chlorotrifluoroethylene (CFO-1113);

a third reactor configured to convert the CFO-1113 of the second mixture to a third mixture comprising 1,1,2-trifluoroethane (HFC-143); and

a fourth reactor configured to convert the HFC-143 of the third mixture to a fourth mixture comprising E-1,2-difluoroethylene (HFO-E-1132) and Z-1,2-difluoroethylene (HFO-Z-1132).

17. The system of claim 16, wherein the first, second, third and fourth reactors are in flow communication with each other.

18. The system of claim 17, wherein the system is an integrated system comprised of the first, second, third and fourth reactors.

19. The system of any one of claims 16 to 18, the system further comprising a conversion system in fluid communication with the fourth reactor, the conversion system being configured to adjust the HFO-1132 E/Z ratio of the fourth mixture.

20. The system of claim 19, wherein the conversion system is selected from the group consisting of a distillation column, a catalyst free thermal converter, and a catalytic reactor.