THE CLAIMS

What is claimed is:

1. A reactor system comprising:

a reaction zone for contacting BF_3 gas with boron-containing solids under temperature and pressure conditions effective to form an intermediate species;

an opening for allowing an unreacted portion of BF_3 gas and the intermediate species to exit the reaction zone into a condensation zone for effecting reaction between the intermediate species and the unreacted portion of the BF_3 gas to form a reaction product comprising B_2F_4;

a recovery zone for recovering the reaction product and unreacted BF_3 gas; and

a recycling zone for recycling the recovered unreacted BF_3 gas to the reaction zone.

2. The reactor system of claim 1, wherein the reaction zone comprises a metal casing and a metal reaction cavity.

3. The reactor system of claim 1, wherein the recycling zone comprises a purification zone effective to reduce impurities in the unreacted BF_3 gas.

4. The reactor system of claim 3, wherein the purification zone comprises a vessel that is cooled to cryogenic temperatures.

5. The reactor system of claim 1, wherein the recovery zone comprises a filtration zone for removing solid particulates from the reaction product and unreacted BF_3 gas.

6. The reactor system of claim 1, wherein the boron-containing solids comprise boron-containing compounds of stoichiometric composition.

7. The reactor system of claim 1, comprising a thermal controller assembly configured to maintain temperature in the reaction zone in a predetermined temperature range.

8. The reactor system of claim 1, comprising boron-containing solids including exposed lattice planes.

9. The reactor system of claim 1, wherein the condensation zone effects reaction between the intermediate species and the unreacted portion of the BF_3 gas to form a reaction product comprising B_2F_4 by cooling the intermediate species and the unreacted portion of the BF_3 gas in a cryogenic temperature range.

10. The reactor system of claim 9, wherein the cryogenic temperature range is controlled by use of a hydraulic lift configured to translate a vessel containing material that can cool at cryogenic temperatures, in a selected one of upward and downward directions, between an uppermost position and a lowermost position.

~~11. A reactor system comprising:~~

~~a reaction zone for contacting a gaseous reagent with a solid material under temperature and pressure conditions effective to form an intermediate species;~~

~~an opening for allowing an unreacted portion of the gaseous reagent and the intermediate species to exit the reaction zone into a condensation zone; and~~

~~a seal surrounding the opening, the seal sealingly connecting the reaction zone to the condensation zone.~~

~~12. The reactor system of claim 11, wherein the seal is effective to sealingly connect the reaction zone to the condensation zone under vacuum or super-atmospheric pressures.~~

~~13. The reactor system of claim 12, wherein the seal comprises an O-ring including a perfluoroelastomer material.~~

~~14. The reactor system of claim 13, wherein the seal is disposed beneath a split flange, the split flange effective to maintain a pressure on the seal.~~

~~15. The reactor system of claim 11, further comprising a thermal controller assembly configured to maintain temperature in the reaction zone in a predetermined temperature range.~~

~~16. The reactor system of claim 11, wherein the reaction zone comprises a double-walled quartz jacket and the condensation zone comprises a stainless steel vessel.~~

~~17~~11. A method of forming B_2F_4 comprising:

reacting BF_3 gas and boron-containing solids to form a first gaseous mixture comprising BF and unreacted BF_3 gas;

cooling the first gaseous mixture under temperature and pressure conditions effective to condense the first gaseous mixture to form a condensed product;

volatilizing the condensed product to form a second gaseous mixture comprising B_2F_4 and BF_3;

filtering the second gaseous mixture to remove particulates; and

recovering B_2F_4 from the second gaseous mixture.

~~18~~12. A method of forming B_2F_4 comprising:

reacting BF_3 gas and boron-containing solids to form a first gaseous mixture comprising BF and unreacted BF_3 gas;

cooling the first gaseous mixture under temperature and pressure conditions effective to condense the first gaseous mixture to form a first condensed product;

volatilizing the first condensed product to form a second gaseous mixture comprising B_2F_4 and BF_3;

cooling the second gaseous mixture under temperature and pressure conditions effective to condense the second gaseous mixture to form a second condensed product and a third gaseous mixture comprising B_2F_4 and BF_3;

filtering the third gaseous mixture to remove particulates; and

recovering B_2F_4 from the third gaseous mixture.

~~19~~13. The method of claim ~~18~~12, further comprising, when the second condensed product comprises unwanted B_xF_y species, removing the B_xF_y species from the condensed product by reacting the B_xF_y species with an active compound selected from XeF_2, F_2, NF_3, O_2, O_3, or CO, to form a residue, and mechanically removing the residue.

~~20~~14. The method of claim ~~18~~12, further comprising, when the second condensed product comprises B_xF_y species, removing the B_xF_y species from the condensed product by reacting the B_xF_y species with an active compound selected from XeF_2, F_2, NF_3, O_2, O_3, or CO, to form a residue, and reacting the residue with a halogen-containing agent to volatilize the residue.

~~21~~15. An apparatus for production of B_2F_4, comprising:

a reactor containing a boron reactant that is reactive with boron trifluoride, BF_3, to yield boron fluoride, BF, wherein said reactor is configured to provide process conditions effective for reaction of BF_3 and said boron reactant to yield BF as a reaction product, and to discharge BF and unreacted BF_3 as a reactor effluent;

a source of BF_3 arranged to supply BF_3 to the reactor;

a condensation zone configured to receive the reactor effluent from the reactor and to provide process conditions effective for condensation of BF and BF_3 to yield B_2F_4; and

a recirculation loop for flowing to the reactor unreacted BF_3 recoverable from the condensation, wherein the recirculation loop comprises a purification unit configured to purify recirculated BF_3 flowed to the reactor.

~~22~~16. The apparatus of claim ~~21~~15, wherein the purification unit comprises a freeze-pump-thaw purification unit.

~~23~~17. The apparatus of claim ~~21~~15, wherein the reactor contains elemental boron as said boron reactant.

~~24~~18. The apparatus of claim ~~23~~17, wherein the elemental boron comprises elemental boron in particulate form.

~~25~~19. A method for production of B_2F_4, comprising:
reacting boron in a reaction zone with boron trifluoride, BF_3, to yield boron fluoride, BF;
condensing BF and unreacted BF_3 from said reacting, to yield B_2F_4;
purifying unreacted BF_3 recovered from said condensing to yield purified BF_3; and
recirculating said purified BF_3 to the reaction zone.

~~26~~20. The method of claim ~~25~~19, wherein said purifying comprises freeze-pump-thaw purification.

~~27~~21. The method of claim ~~25~~19, wherein said boron is in particulate form.

~~28. A method of producing boron monofluoride, comprising reacting boron trifluoride with a boron-containing solid to form boron monofluoride, wherein said boron-containing solid is in a monocrystalline form comprising crystal planes of differing reactivity to boron trifluoride, and a major fraction of surface area of said monocrystalline boron-containing solid exposed to boron trifluoride in said reacting comprises surface area of a crystal plane having higher reactivity to boron trifluoride than other crystal plane(s) of said monocrystalline boron-containing solid.~~

~~29. The method of claim 28, wherein the boron-containing solid is elemental boron.~~

~~30. A boron-containing solid of monocrystalline form comprising crystal planes of differing reactivity to boron trifluoride, wherein a major fraction of surface area of said monocrystalline boron-containing solid comprises surface area of a crystal plane having higher reactivity to boron trifluoride than other crystal plane(s) of said monocrystalline boron-containing solid.~~

~~31. The boron-containing solid of claim 30, comprising elemental boron monocrystalline particles.~~

THE CLAIMS

What is claimed is:

1. A reactor system comprising:

a reaction zone for contacting BF_3 gas with boron-containing solids under temperature and pressure conditions effective to form an intermediate species;

an opening for allowing an unreacted portion of BF_3 gas and the intermediate species to exit the reaction zone into a condensation zone for effecting reaction between the intermediate species and the unreacted portion of the BF_3 gas to form a reaction product comprising B_2F_4;

a recovery zone for recovering the reaction product and unreacted BF_3 gas; and

a recycling zone for recycling the recovered unreacted BF_3 gas to the reaction zone.

2. The reactor system of claim 1, wherein the reaction zone comprises a metal casing and a metal reaction cavity.

3. The reactor system of claim 1, wherein the recycling zone comprises a purification zone effective to reduce impurities in the unreacted BF_3 gas.

4. The reactor system of claim 3, wherein the purification zone comprises a vessel that is cooled to cryogenic temperatures.

5. The reactor system of claim 1, wherein the recovery zone comprises a filtration zone for removing solid particulates from the reaction product and unreacted BF_3 gas.

6. The reactor system of claim 1, wherein the boron-containing solids comprise boron-containing compounds of stoichiometric composition.

7. The reactor system of claim 1, comprising a thermal controller assembly configured to maintain temperature in the reaction zone in a predetermined temperature range.

8. The reactor system of claim 1, comprising boron-containing solids including exposed lattice planes.

9. The reactor system of claim 1, wherein the condensation zone effects reaction between the intermediate species and the unreacted portion of the BF_3 gas to form a reaction product comprising B_2F_4 by cooling the intermediate species and the unreacted portion of the BF_3 gas in a cryogenic temperature range.

10. The reactor system of claim 9, wherein the cryogenic temperature range is controlled by use of a hydraulic lift configured to translate a vessel containing material that can cool at cryogenic temperatures, in a selected one of upward and downward directions, between an uppermost position and a lowermost position.

11. A method of forming B_2F_4 comprising:

reacting BF_3 gas and boron-containing solids to form a first gaseous mixture comprising BF and unreacted BF_3 gas;

cooling the first gaseous mixture under temperature and pressure conditions effective to condense the first gaseous mixture to form a condensed product;

volatilizing the condensed product to form a second gaseous mixture comprising B_2F_4 and BF_3;

filtering the second gaseous mixture to remove particulates; and

recovering B_2F_4 from the second gaseous mixture.

12. A method of forming B_2F_4 comprising:

reacting BF_3 gas and boron-containing solids to form a first gaseous mixture comprising BF and unreacted BF_3 gas;

cooling the first gaseous mixture under temperature and pressure conditions effective to condense the first gaseous mixture to form a first condensed product;

volatilizing the first condensed product to form a second gaseous mixture comprising B_2F_4 and BF_3;

cooling the second gaseous mixture under temperature and pressure conditions effective to condense the second gaseous mixture to form a second condensed product and a third gaseous mixture comprising B_2F_4 and BF_3;

filtering the third gaseous mixture to remove particulates; and

recovering B_2F_4 from the third gaseous mixture.

13. The method of claim 12, further comprising, when the second condensed product comprises unwanted B_xF_y species, removing the B_xF_y species from the condensed product by

reacting the B_xF_y species with an active compound selected from XeF_2, F_2, NF_3, O_2, O_3, or CO, to form a residue, and mechanically removing the residue.

14. The method of claim 12, further comprising, when the second condensed product comprises B_xF_y species, removing the B_xF_y species from the condensed product by reacting the B_xF_y species with an active compound selected from XeF_2, F_2, NF_3, O_2, O_3, or CO, to form a residue, and reacting the residue with a halogen-containing agent to volatilize the residue.

15. An apparatus for production of B_2F_4, comprising:

a reactor containing a boron reactant that is reactive with boron trifluoride, BF_3, to yield boron fluoride, BF, wherein said reactor is configured to provide process conditions effective for reaction of BF_3 and said boron reactant to yield BF as a reaction product, and to discharge BF and unreacted BF_3 as a reactor effluent;

a source of BF_3 arranged to supply BF_3 to the reactor;

a condensation zone configured to receive the reactor effluent from the reactor and to provide process conditions effective for condensation of BF and BF_3 to yield B_2F_4; and

a recirculation loop for flowing to the reactor unreacted BF_3 recoverable from the condensation, wherein the recirculation loop comprises a purification unit configured to purify recirculated BF_3 flowed to the reactor.

16. The apparatus of claim 15, wherein the purification unit comprises a freeze-pump-thaw purification unit.

17. The apparatus of claim 15, wherein the reactor contains elemental boron as said boron reactant.

18. The apparatus of claim 17, wherein the elemental boron comprises elemental boron in particulate form.

19. A method for production of B_2F_4, comprising:

reacting boron in a reaction zone with boron trifluoride, BF_3, to yield boron fluoride, BF;

condensing BF and unreacted BF_3 from said reacting, to yield B_2F_4;

purifying unreacted BF_3 recovered from said condensing to yield purified BF_3; and

recirculating said purified BF_3 to the reaction zone.

20. The method of claim 19, wherein said purifying comprises freeze-pump-thaw purification.

21. The method of claim 19, wherein said boron is in particulate form.