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 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 and 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;

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, wherein the recycling zone comprises a purification zone effective to reduce impurities in the unreacted BF_3 gas.

2. 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; the reaction zone comprises a double-walled quartz jacket;

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; the condensation zone comprises a stainless steel vessel and a seal surrounding the opening, the seal sealingly connecting the reaction zone to the condensation zone, wherein the seal is effective to sealingly connect the reaction zone to the condensation zone under vacuum or super-atmospheric pressures;

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, wherein the recycling zone comprises a purification zone effective to reduce impurities in the unreacted BF_3 gas.

3. The reactor system of claim 2, wherein the seal comprises an O-ring including a perfluoroelastomer material disposed beneath a split flange, the split flange effective to maintain a pressure on the seal.

4. 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, wherein the purification unit comprises a freeze-pump-thaw purification unit.

5. The apparatus of claim 4, wherein the reactor contains elemental boron as said boron reactant.

6. The apparatus of claim 5, wherein the elemental boron is in a monocrystalline form comprising crystal planes of differing reactivity to boron trifluoride, and a major fraction of surface area of said elemental boron exposed to boron trifluoride as said boron reactant comprises surface area of a crystal plane having higher reactivity to boron trifluoride than other crystal plane(s) of said monocrystalline boron.

7. A method for production of B_2F_4, using the reactor of claim 4, said method comprising:
reacting boron surfactant in a reaction zone of the reactor with said source of BF_3 arranged to supply boron trifluoride, BF_3, to the reactor to yield boron fluoride, BF; said reactor 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;

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

purifying unreacted BF_3 recovered from said condensing in the recirculation loop, said recirculation loop for flowing to the reactor unreacted BF_3 recoverable from the condensation comprises a freeze-pump-thaw purification unit configured to yield purified BF_3; and

recirculating said purified BF_3 to the reaction zone of the reactor, wherein said purifying comprises freeze-pump-thaw purification.

8. The method of claim 7, wherein said boron 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 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.