

Claims

1. A method of selectively dry etching a substrate, comprising the steps of:
 - providing a substrate in an etch chamber, said substrate comprising a silicon-germanium alloy layer and a silicon layer;
 - introducing a fluorine-containing interhalogen gas into the etch chamber;
 - selectively etching a first portion of the silicon-germanium alloy layer that is subsequently removed from the etch chamber as a first portion of volatized fluorides of silicon and germanium;
 - converting the silicon layer into a non-volatized fluorinated silicon layer;
 - withdrawing any residual amount of the fluorine-containing interhalogen gas from the etch chamber;
 - introducing a passivating gas into the etch chamber to selectively convert the non-volatized fluorinated silicon layer into a passivating silicon layer, whereby the passivating gas does not substantially react with the silicon-germanium alloy layer;
 - withdrawing any residual amount of the passivating gas from the etch chamber;
 - re-introducing the fluorine-containing interhalogen gas into the etch chamber; and
 - selectively etching a second portion of the silicon-germanium alloy layer that is subsequently removed from the etch chamber as a second portion of volatized fluorides of silicon and germanium without substantial etching of the passivating silicon layer.
2. The method of claim 1, further comprising repeating the step of re-introducing the fluorine-containing interhalogen gas into the etch chamber one or more times to further react with the silicon-germanium alloy layer until a predetermined amount of the silicon-germanium alloy layer is selectively etched and subsequently removed from the etch chamber without substantial etching of the passivating silicon layer.
3. The method of claim 2, further comprising the steps of:

removing the passivating silicon layer to expose the silicon layer when the predetermined amount of the silicon-germanium alloy layer has been selectively etched and subsequently removed from the process chamber.

4. The method of claim 1, wherein the passivating gas is selected from the group consisting of NH_3 , H_2O , O_2 , compounds with an alcohol functional group, H_2S , H_2Se and any combination thereof.
5. The method of claim 1, wherein the passivating silicon layer is selected from the group consisting of silicon oxide, silicon sulfide, silicon nitride, silicon selenide and a fluorosilicate salt.
6. The method of claim 1, wherein the passivating silicon layer comprises incorporation of carbon or hydrogen as a self-assembled monomer or alkyl chain.
7. The method of claim 2, further comprising re-introducing the passivating gas into the etch chamber to re-establish the passivating silicon layer prior to the step of repeating the re-introducing of the fluorine-containing interhalogen gas into the etch chamber one or more times.
8. The method of claim 1, further comprising withdrawing the residual amount of the fluorine-containing interhalogen gas after converting the silicon layer into the non-volatized fluorinated silicon layer, and prior to introducing the passivating gas into the etch chamber.
9. The method of claim 1, wherein the step of withdrawing the residual amount of the passivating gas occurs after converting the non-volatized fluorinated silicon layer into the passivating silicon layer and prior to re-introducing the fluorine-containing interhalogen gas into the etch chamber.

10. A method of selectively dry etching a substrate, comprising the steps of:
- providing a substrate in an etch chamber, said substrate comprising a silicon-germanium alloy layer and a silicon layer;
 - introducing a first etchant gas into the etch chamber, wherein said first etchant gas comprises a fluorine-containing interhalogen gas;
 - selectively etching a first portion of the silicon-germanium alloy layer that is subsequently removed from the etch chamber as a first portion of volatized fluorides of silicon and germanium;
 - converting the silicon layer into a non-volatized fluorinated silicon layer;
 - withdrawing any residual amount of the fluorine-containing interhalogen gas from the etch chamber;
 - introducing a passivating gas into the etch chamber to selectively convert the non-volatized fluorinated silicon layer into a passivating silicon layer, whereby the passivating gas does not substantially react with the silicon-germanium alloy layer;
 - withdrawing any residual amount of the passivating gas from the etch chamber;
 - introducing a second etchant gas into the etch chamber; and
 - selectively etching a second portion of the silicon-germanium alloy layer that is subsequently removed from the etch chamber as a second portion of volatized fluorides of silicon and germanium without substantial etching of the passivating silicon layer.
11. The method of claim 10, wherein the second etchant gas is selected from the group consisting of CF₄, C₄F₈, C₄F₆, CH₃F, F₂, XeF₂, NF₃ and any combination thereof.
12. The method of claim 10, further comprising the step of re-introducing an additional amount of the second etchant gas into the etch chamber to further react with the silicon-germanium alloy layer until a predetermined amount of the silicon-germanium alloy layer is selectively etched without substantial etching of the passivating silicon layer.
13. The method of claim 12, further comprising the step of:

removing the passivating silicon layer when the predetermined amount of the silicon-germanium alloy layer is selectively etched and subsequently removed from the etch chamber.

14. The method of claim 12, further comprising re-introducing the passivating gas into the etch chamber to re-establish the passivating silicon layer prior to the step of re-introducing the additional amount of the second etchant gas into the etch chamber.

15. The method of claim 10, further comprising withdrawing the residual amount of the fluorine-containing interhalogen gas after converting the silicon layer into the non-volatized fluorinated silicon layer and prior to introducing the passivating gas into the etch chamber.

16. The method of claim 10, further comprising withdrawing the residual amount of the passivating gas after converting the non-volatized fluorinated silicon layer into the passivating silicon layer and prior to introducing the second etchant gas into the etch chamber.

17. A method of selectively dry etching a substrate, comprising the steps of:
providing a substrate in an etch chamber, said substrate comprising a silicon-germanium alloy layer and a silicon layer, wherein said silicon-germanium alloy layer is in-situ doped with an n-type or p-type dopant;
exposing the substrate to an etchant gas; and
selectively removing a portion of the silicon-germanium alloy layer of silicon and germanium without substantial removal of the passivating silicon layer.

18. The method of claim 17, wherein the etchant gas is selected from the group consisting of BF₃, NF₃, NH₃, PH₃, AsH₃, PF₃, PF₅, AsF₃, AsF₅, B₂H₆, SbF₅, dimethyl aluminum chloride, trimethyl gallium, trimethyl aluminum, AlCl₃, AlI₃, GaCl₃, GaI₃, SbF₃, Sb₂O₃, and trimethyl antimony and any combination thereof.

19. A method of selectively dry etching a substrate, comprising the steps of:
providing a substrate in an etch chamber, said substrate comprising a silicon-germanium alloy layer and a silicon layer; and
selectively etching the silicon-germanium alloy layer with the use of an interhalogen fluorine-containing gas while creating and maintaining a passivating layer on the Si layer.
20. The method of claim 19, wherein the passivating layer is formed by flowing a passivating gas into the etch chamber towards an exposed surface of the silicon layer.
21. The method of claim 20, wherein the passivating gas is flowed into the etch chamber after etching a first portion of the silicon-germanium alloy layer with the interhalogen fluorine-containing gas, thereby exposing at least a portion of the silicon layer.
22. The method of claim 19, further comprising introducing an additional gas species into the etch chamber, said additional gas species comprising a rate inhibitor species to reduce a rate of etching on the Si layer more than that of the silicon-germanium.
23. The method of claim 19, further comprising introducing an additional gas species into the etch chamber, said additional gas species comprising a rate enhancer species to increase a rate of etching on the silicon-germanium layer more than that of the Si layer.
24. The method of claim 19, further comprising introducing additional gas species into the etch chamber, said additional gas species comprising a rate inhibitor species and a rate enhancer species.