What is claimed is:

1. A method of forming a patterned magnetic substrate, comprising:

forming a patterned resist having thick portions and thin portions on a magnetically active surface of a substrate;

forming a stabilizing layer over the patterned resist;

exposing portions of the magnetically active surface to directed energy through the stabilizing layer and the thin portions of the patterned resist; and

modifying a magnetic property of the exposed portions of the magnetically active surface to form the patterned magnetic substrate.

2. The method of claim 1, wherein forming the patterned resist comprises a physical patterning process.

3. The method of claim 1, wherein forming the stabilizing layer comprises depositing a silicon containing layer over the patterned resist at a temperature below about 150°C.

4. The method of claim 3, wherein depositing the silicon containing layer over the patterned resist comprises:

providing a silicon precursor and an oxidizing gas to a processing chamber;

maintaining a temperature of the substrate below about 150°C; and

activating the oxidizing gas..

5. The method of claim 4, wherein the processing chamber is a plasma immersion chamber.

6. The method of claim 5, wherein the processing chamber comprises remote plasma source.

7. The method of claim 1, wherein the directed energy comprises fluorine containing ions.

8. The method of claim 1, wherein exposing portions of the magnetically active surface to directed energy through the stabilizing layer and the thin portions comprises:

providing a fluorine containing gas mixture to a processing chamber with an inductive plasma source;

generating a plasma from the fluorine containing gas; and

directing ions from the plasma toward the substrate at an energy selected to penetrate the thin portions of the resist but not the thick portions of the resist.

9. The method of claim 1, wherein exposing portions of the magnetically active surface to directed energy through the stabilizing layer and the thin portions comprises:

generating a fluorine containing ion beam; and

directing the fluorine containing ion beam toward the substrate, wherein the ions have an average kinetic energy selected to penetrate the thin portions of the resist but not the thick portions of the resist.

10. The method of claim 1, further comprising removing the stabilizing layer and the patterned resist by exposing the substrate to a fluorine containing gas.

11. A method of forming a patterned magnetic substrate, comprising:

forming a magnetically active layer on a structural substrate;

forming a pattern transfer layer on the magnetically active layer;

patterning the pattern transfer layer by a physical patterning process;

forming a conformal silicon-containing protective layer over the pattern transfer layer by an atomic layer deposition process; and

modifying the magnetic properties of the magnetically active layer according to the pattern formed in the pattern transfer layer by exposing the substrate to energy selected to penetrate portions of the pattern transfer layer.

12. A substrate having a magnetically susceptible layer, the magnetically susceptible layer comprising:

a first plurality of domains having a magnetic property with a first value;

a second plurality of domains having a second value of the magnetic property; and

a transition region between the first plurality of domains and the second plurality of domains, the transition region having a dimension less than about 2nm, wherein each of the first plurality of domains and the second plurality of domains has a dimension less than about 25 nm.

13. A magnetic media substrate formed by a process comprising:

forming a magnetically active layer on a structural substrate;

forming a patterned resist having thick portions and thin portions in contact with the magnetically active layer;

forming a conformal stabilizing layer over the patterned resist;

exposing portions of the magnetically active surface to directed energy through the stabilizing layer and the thin portions of the patterned resist;

modifying a magnetic property of the exposed portions of the magnetically active surface to form a patterned magnetic substrate; and

removing the patterned resist and the stabilizing layer.

14. An apparatus for processing a substrate, comprising:

a substrate handing portion coupled to a substrate processing portion by one or more load-lock chambers, the substrate processing portion comprising a PEALD

chamber and one or more plasma immersion chambers coupled to a transfer chamber, and the substrate handling portion comprising a loading portion, a transfer portion, a flipping portion, and an interface portion.

15. The apparatus of claim 14, wherein the substrate processing portion further comprises a plasma cleaning chamber.

CLAIMS

1. A method of forming a patterned magnetic substrate, comprising:

forming a patterned resist having thick portions and thin portions on a magnetically active surface of a substrate;

forming a stabilizing layer over the patterned resist;

exposing portions of the magnetically active surface to directed energy through the stabilizing layer and the thin portions of the patterned resist; and

modifying a magnetic property of the exposed portions of the magnetically active surface.

2. The method of claim 1, wherein forming the patterned resist comprises a physical patterning process.

3. The method of claim 1, wherein the stabilizing layer is a silicon containing layer.

4. The method of claim 1, wherein forming the stabilizing layer comprises depositing a silicon containing layer over the patterned resist at a temperature below about 150°C.

5. The method of claim 2, wherein the physical patterning process is a nano-imprint process, and the stabilizing layer is a silicon containing layer.

6. The method of claim 4, wherein depositing the silicon containing layer over the patterned resist comprises:

providing a silicon precursor and an oxidizing gas to a processing chamber;

maintaining a temperature of the substrate below about 150°C; and

activating the oxidizing gas.

7. The method of claim 6, wherein the processing chamber is a plasma immersion chamber.

8. The method of claim 7, wherein the processing chamber comprises remote plasma source.

9. The method of claim 1, wherein the directed energy comprises ions, neutrals, radicals, photons, electrons, or a combination thereof.

10. The method of claim 1, wherein the directed energy comprises fluorine containing ions.

11. The method of claim 1, wherein exposing portions of the magnetically active surface to directed energy through the stabilizing layer and the thin portions comprises:

providing a fluorine containing gas mixture to a processing chamber with an inductive plasma source;

generating a plasma from the fluorine containing gas; and

directing ions from the plasma toward the substrate at an energy selected to penetrate the thin portions of the resist but not the thick portions of the resist.

12. The method of claim 1, wherein exposing portions of the magnetically active surface to directed energy through the stabilizing layer and the thin portions comprises:

generating a fluorine containing ion beam; and

directing the fluorine containing ion beam toward the substrate, wherein the ions have an average kinetic energy selected to penetrate the thin portions of the resist but not the thick portions of the resist.

13. The method of claim 1, further comprising removing the stabilizing layer and the patterned resist.

14. The method of claim 13, wherein removing the stabilizing layer and the patterned resist comprises exposing the substrate to a fluorine containing gas.

15. A method of forming a patterned magnetic substrate, comprising:

forming a magnetically active layer on a structural substrate;

forming a pattern transfer layer on the magnetically active layer;

patterning the pattern transfer layer by a physical patterning process;

forming a conformal protective layer over the pattern transfer layer; and

modifying the magnetic properties of the magnetically active layer according to the pattern formed in the pattern transfer layer by exposing the substrate to energy selected to penetrate portions of the pattern transfer layer.

16. The method of claim 15, wherein forming the conformal protective layer over the pattern transfer layer comprises depositing a silicon-containing layer over the pattern transfer layer in an atomic layer deposition process.