Claims

What is claimed is:

1. A method comprising:

providing a substrate having an integrated circuit (IC) structure disposed on the substrate, the IC structure including a magnetizable material;

implanting at least a portion of the magnetizable material with a dopant; and

magnetizing the magnetizable material, wherein said magnetizing is inhibited in the implanted portion of the magnetizable material.

2. The method of claim 1, wherein the substrate is a semiconductor substrate, the method further comprising:

forming the IC structure, wherein said forming the IC structure includes depositing the magnetizable material to form a magnetic layer of magnetic memory, the magnetizable material comprising a metal selected from a group consisting of cobalt (Co), iron (Fe), nickel (Ni), and an alloy of two or more of Co, Fe, or Ni with or without boron (B).

3. The method of claim 2, wherein forming the IC structure further comprises:

depositing one or more magnetic base layers on the substrate;

depositing a tunnel barrier layer on the one or more magnetic base layers; and

depositing a barrier layer on the magnetic layer, wherein the magnetizable material is deposited on the tunnel barrier layer.

4. The method of any of claims 1-3, wherein said implanting comprises implanting at least a portion of the IC structure with a dopant selected from a group consisting of boron (B), carbon (C), nitrogen (N), oxygen (O), phosphorous (P), germanium (Ge) and xenon (Xe).

5. The method of any of claims 1-3, further comprising:

depositing a masking layer on the IC structure; and

patterning the masking layer to expose portions of the IC structure, wherein said implanting comprises implanting the exposed portions of the IC structure.

6. The method of claim 5, further comprising:

performing an etch process to remove material of the exposed portions of the IC structure.

7. The method of any of claims 1-3, wherein said magnetizing is performed by annealing the magnetizable material in the presence of a magnetic field.

8. A method comprising:

providing a substrate having an integrated circuit (IC) structure disposed on the substrate, the IC structure including a magnetizable material;

magnetizing the magnetizable material; and

implanting at least a portion of the magnetized material with a dopant to reduce a magnetic moment in the implanted portion of the magnetized material.

9. The method of claim 8, wherein the substrate is a semiconductor substrate, the method further comprising:

forming the IC structure, wherein said forming the IC structure includes depositing the magnetizable material to form a magnetic layer of magnetic memory, the magnetizable material comprising a metal selected from a group consisting of cobalt (Co), iron (Fe), nickel (Ni), and an alloy of two or more of Co, Fe, or Ni with or without boron (B).

10. The method of claim 9, wherein forming the IC structure further comprises:

depositing one or more magnetic base layers on the substrate;

depositing a tunnel barrier layer on the one or more magnetic base layers; and

depositing a barrier layer on the magnetic layer, wherein the magnetizable material is deposited on the tunnel barrier layer.

11. The method of any of claims 8-10, wherein said implanting comprises implanting at least a portion of the IC structure with a dopant selected from a group consisting of boron (B), carbon (C), nitrogen (N), oxygen (O), phosphorous (P), germanium (Ge) and xenon (Xe).

12. The method of any of claims 8-10, further comprising:

depositing a masking layer on the IC structure; and

patterning the masking layer to expose portions of the IC structure, wherein said implanting comprises implanting the exposed portions of the IC structure.

13. The method of claim 12, further comprising:

performing an etch process to remove material of the exposed portions of the IC structure.

14. The method of any of claims 8-10, wherein said magnetizing is performed by annealing the magnetizable material in the presence of a magnetic field.

15. An apparatus comprising:

a substrate; and

an integrated circuit (IC) structure disposed on the substrate, the IC structure including a magnetic layer, wherein:

the magnetic layer has a first portion that is implanted with a dopant and a second portion that is not implanted with the dopant; and

the first portion has a magnetic moment that is less than a magnetic moment of the second portion.

16. The apparatus of claim 15, wherein:

the magnetic layer includes a metal selected from a group consisting of cobalt (Co), iron (Fe), nickel (Ni), and an alloy of two or more of Co, Fe, or Ni with or without boron (B).

17. The apparatus of claim 15, wherein the substrate is a semiconductor substrate and the IC structure further comprises:

one or more magnetic base layers disposed on the semiconductor substrate;

a tunnel barrier layer disposed on the one or more magnetic base layers; and

a barrier layer disposed on the magnetic layer, wherein the magnetic layer is disposed on the tunnel barrier layer.

18. The apparatus of any of claims 15-17, further comprising:

a dielectric material in direct contact with the first portion of the magnetic layer.

19. The apparatus of any of claims 15-17, further comprising:

an electrode disposed on the magnetic layer.

20. The apparatus of any of claims 15-17, wherein the first portion of the magnetic layer has substantially no magnetic moment.

21. A computing device comprising:

a circuit board; and

a die coupled with the circuit board, the die including:

a substrate; and

an integrated circuit (IC) structure disposed on the substrate, the IC structure including a magnetic layer, wherein:

the magnetic layer has a first portion that is implanted with a dopant and a second portion that is not implanted with the dopant; and

the first portion has a magnetic moment that is less than a magnetic moment of the second portion.

22. The computing device of claim 21, wherein:

the die comprises magnetic random access memory (MRAM); and

the computing device is a mobile computing device including one or more of an antenna, a display, a touchscreen display, a touchscreen controller, a battery, an audio codec, a video codec, a power amplifier, a global positioning system (GPS) device, a compass, a Geiger counter, an accelerometer, a gyroscope, a speaker, and a camera.

Claims

What is claimed is:

1. A method comprising:

providing a substrate having an integrated circuit (IC) structure disposed on the substrate, the IC structure including a magnetizable material;

implanting at least a portion of the magnetizable material with a dopant; and

magnetizing the magnetizable material, wherein said magnetizing is inhibited in the implanted portion of the magnetizable material.

2. The method of claim 1, wherein the substrate is a semiconductor substrate, the method further comprising:

forming the IC structure, wherein said forming the IC structure includes depositing the magnetizable material to form a magnetic layer of magnetic memory, the magnetizable material comprising a metal selected from a group consisting of cobalt (Co), iron (Fe), nickel (Ni), and an alloy of two or more of Co, Fe, Ni with or without boron (B).

3. The method of claim 2, wherein forming the IC structure further comprises:

depositing one or more magnetic base layers on the substrate;

depositing a tunnel barrier layer on the one or more magnetic base layers; and

depositing a barrier layer on the magnetic layer, wherein the magnetizable material is deposited on the tunnel barrier layer.

4. The method of claim 1, wherein said implanting comprises implanting at least a portion of the IC structure with a dopant selected from a group consisting of boron (B), carbon (C), nitrogen (N), oxygen (O), phosphorous (P), germanium (Ge) and xenon (Xe).

5. The method of claim 1, further comprising:

depositing a masking layer on the IC structure; and

patterning the masking layer to expose portions of the IC structure, wherein said implanting comprises implanting the exposed portions of the IC structure.

6. The method of claim 5, further comprising:

performing an etch process to remove material of the exposed portions of the IC structure.

7. The method of claim 1, wherein said magnetizing is performed by annealing the magnetizable material in the presence of a magnetic field.

8. A method comprising:

providing a substrate having an integrated circuit (IC) structure disposed on the substrate, the IC structure including a magnetizable material;

magnetizing the magnetizable material; and

implanting at least a portion of the magnetized material with a dopant to reduce a magnetic moment in the implanted portion of the magnetized material.

9. The method of claim 8, wherein the substrate is a semiconductor substrate, the method further comprising:

forming the IC structure, wherein said forming the IC structure includes depositing the magnetizable material to form a magnetic layer of magnetic memory, the magnetizable material comprising a metal selected from a group consisting of cobalt (Co), iron (Fe), nickel (Ni), and an alloy of two or more of Co, Fe, Ni with or without boron (B).

10. The method of claim 9, wherein forming the IC structure further comprises:

depositing one or more magnetic base layers on the substrate;

depositing a tunnel barrier layer on the one or more magnetic base layers; and

depositing a barrier layer on the magnetic layer, wherein the magnetizable material is deposited on the tunnel barrier layer.

11. The method of claim 8, wherein said implanting comprises implanting at least a portion of the IC structure with a dopant selected from a group consisting of boron (B), carbon (C), nitrogen (N), oxygen (O), phosphorous (P), germanium (Ge) and xenon (Xe).

12. The method of claim 8, further comprising:

depositing a masking layer on the IC structure; and

patterning the masking layer to expose portions of the IC structure, wherein said implanting comprises implanting the exposed portions of the IC structure.

13. The method of claim 12, further comprising:

performing an etch process to remove material of the exposed portions of the IC structure.

14. The method of claim 8, wherein said magnetizing is performed by annealing the magnetizable material in the presence of a magnetic field.

15. An apparatus comprising:

a substrate; and

an integrated circuit (IC) structure disposed on the substrate, the IC structure including a magnetic layer, wherein:

the magnetic layer has a first portion that is implanted with a dopant and a second portion that is not implanted with the dopant; and

the first portion has a magnetic moment that is less than a magnetic moment of the second portion.

16. The apparatus of claim 15, wherein:

the magnetic layer includes a metal selected from a group consisting of cobalt (Co), iron (Fe), nickel (Ni), and an alloy of two or more of Co, Fe, Ni with or without boron (B).

17. The apparatus of claim 15, wherein the substrate is a semiconductor substrate and the IC structure further comprises:

one or more magnetic base layers disposed on the semiconductor substrate;

a tunnel barrier layer disposed on the one or more magnetic base layers; and

a barrier layer disposed on the magnetic layer, wherein the magnetic layer is disposed on the tunnel barrier layer.

18. The apparatus of claim 15, further comprising:

a dielectric material in direct contact with the first portion of the magnetic layer.

19. The apparatus of claim 15, further comprising:

an electrode disposed on the magnetic layer.

20. The apparatus of claim 15, wherein the first portion of the magnetic layer has substantially no magnetic moment.

21. A computing device comprising:

a circuit board; and

a die coupled with the circuit board, the die including:

a substrate; and

an integrated circuit (IC) structure disposed on the substrate, the IC structure including a magnetic layer, wherein:

the magnetic layer has a first portion that is implanted with a dopant and a second portion that is not implanted with the dopant; and

the first portion has a magnetic moment that is less than a magnetic moment of the second portion.

22. The computing device of claim 21, wherein:

the die comprises magnetic random access memory (MRAM); and

the computing device is a mobile computing device including one or more of an antenna, a display, a touchscreen display, a touchscreen controller, a battery, an audio codec, a video codec, a power amplifier, a global positioning system (GPS) device, a compass, a Geiger counter, an accelerometer, a gyroscope, a speaker, and a camera.