CLAIMS

1. A magnetoresistive device having a magnetic junction, the magnetic junction comprising:

a first magnetic layer structure having a magnetization orientation, the first magnetic layer structure comprising a first sub-layer and a second sub-layer;

a second magnetic layer structure having a magnetization orientation that is fixed or that is able to oscillate; and

a free magnetic layer structure having a variable magnetization orientation;

wherein the second magnetic layer structure is arranged on top of the free magnetic layer structure;

wherein the free magnetic layer structure is arranged on top of the first magnetic layer structure, in between the first magnetic layer structure and the second magnetic layer structure;

wherein the first sub-layer of the first magnetic layer structure, the second magnetic layer structure and the free magnetic layer structure have perpendicular anisotropy;

wherein the second sub-layer of the first magnetic layer structure has in-plane anisotropy;

wherein a magnetization orientation of the first sub-layer of the first magnetic layer structure and the magnetization orientation of the second magnetic layer structure are oriented in opposite directions;

wherein the magnetization orientation of the first sub-layer of the first magnetic layer structure is configured to oscillate in a first direction in response to a current or a voltage applied across the magnetic junction so as to change the magnetization orientation of the free magnetic layer structure; and

wherein the free magnetic layer structure is adapted to function as a memory storage layer.

2. The magnetoresistive device as claimed in claim 1,

wherein the magnetization orientation of the second magnetic layer structure is able to oscillate and is configured to oscillate in a second direction in response to the current or the voltage applied across the magnetic junction so as to change the magnetization orientation of the free magnetic layer structure, the second direction being opposite to the first direction.

3. The magnetoresistive device as claimed in claim 1,

wherein each of the free magnetic layer structure and the second magnetic layer structure comprises at least one of iron, cobalt or nickel.

4. The magnetoresistive device as claimed in claim 1,

wherein each of the free magnetic layer structure and the second magnetic layer structure comprises cobalt-iron-boron or a bilayer structure comprising a first layer of material selected from the group consisting of cobalt, cobalt-iron and cobalt-iron-boron, and a second layer of material selected from the group consisting of palladium, platinum and a combination thereof.

5. The magnetoresistive device as claimed in claim 1,

wherein the first magnetic layer structure comprises:

a ferromagnetic layer and a ferromagnetic hard layer, the ferromagnetic layer defining the first sub-layer, and the ferromagnetic hard layer defining the second sub-layer;

wherein the ferromagnetic layer defining the first sub-layer is arranged on top of the ferromagnetic hard layer,

wherein the ferromagnetic layer defining the first sub-layer has perpendicular anisotropy,

wherein the magnetization orientation of the ferromagnetic layer defining the first sub-layer is configured to oscillate in the first direction in response to the current or the voltage applied across the magnetic junction; and

wherein the ferromagnetic hard layer has in-plane anisotropy.

6. The magnetoresistive device as claimed in claim 5,

wherein the first magnetic layer structure further comprises a spacer layer between the ferromagnetic layer and the ferromagnetic hard layer.

7. The magnetoresistive device as claimed in claim 6,

wherein the spacer layer comprises a conductive and non-magnetic material.

8. The magnetoresistive device as claimed in claim 5,

wherein the ferromagnetic hard layer comprises a synthetic antiferromagnetic layer, the synthetic antifferomagnetic layer comprising two antiferromagnetically coupled ferromagnetic layers pinned by an antiferromagnetic layer.

9. The magnetoresistive device as claimed in claim 5,

wherein the first magnetic layer structure further comprises an antiferromagnetic layer arranged adjacent to the ferromagnetic hard layer.

10. The magnetoresistive device as claimed in claim 9,

wherein the antiferromagnetic layer comprises a material comprising X-manganese or X-Y-manganese, wherein each of X and Y is selected from the group consisting of platinum, palladium, iridium, rhodium and ruthenium.

11. The magnetoresistive device as claimed in claim 1,

wherein the first magnetic layer structure comprises:

a first ferromagnetic layer defining the first sub-layer;

a second ferromagnetic layer defining the second sub-layer; and

a ferromagnetic hard layer;

wherein the first ferromagnetic layer is arranged on top of the second ferromagnetic layer,

wherein the second ferromagnetic layer is arranged on top of the ferromagnetic hard layer, in between the first ferromagnetic layer and the ferromagnetic hard layer,

wherein the first ferromagnetic layer and the ferromagnetic hard layer have perpendicular anisotropy,

wherein the magnetization orientation of the first ferromagnetic layer is configured to oscillate in the first direction in response to the current or the voltage applied across the magnetic junction; and

wherein the second ferromagnetic layer has in-plane anisotropy.

12. The magnetoresistive device as claimed in claim 11,

wherein the first magnetic layer structure further comprises:

a first spacer layer between the first ferromagnetic layer and the second ferromagnetic layer; and

a second spacer layer between the second ferromagnetic layer and the ferromagnetic hard layer.

13. The magnetoresistive device as claimed in claim 12,

wherein each of the first spacer layer and the second spacer layer comprises a conductive and non-magnetic material.

14. The magnetoresistive device as claimed in claim 11,

wherein the first magnetic layer structure further comprises an antiferromagnetic layer arranged adjacent to the ferromagnetic hard layer.

15. The magnetoresistive device as claimed in claim 14,

wherein the antiferromagnetic layer comprises a material comprising X-manganese or X-Y-manganese, wherein each of X and Y is selected from the group consisting of platinum, palladium, iridium, rhodium and ruthenium.

16. A magnetoresistive device having a magnetic junction, the magnetic junction comprising:

a first magnetic layer structure having a magnetization orientation, the first magnetic layer structure comprising a first sub-layer and a second sub-layer;

a second magnetic layer structure having a magnetization orientation; and

a free magnetic layer structure having a variable magnetization orientation;

wherein the second magnetic layer structure is arranged on top of the free magnetic layer structure,

wherein the free magnetic layer structure is arranged on top of the first magnetic layer structure, in between the first magnetic layer structure and the second magnetic layer structure,

wherein the first sub-layer of the first magnetic layer structure, the second magnetic layer structure and the free magnetic layer structure have perpendicular anisotropy;

wherein the second sub-layer of the first magnetic layer structure has in-plane anisotropy;

wherein a magnetization orientation of the first sub-layer of the first magnetic layer structure and the magnetization of the second magnetic layer structure are oriented in opposite directions;

wherein the magnetization orientation of the first sub-layer of the first magnetic layer structure is configured to oscillate in a first direction in response to a current or a voltage applied across the magnetic junction so as to change the magnetization orientation of the free magnetic layer structure; and

wherein the magnetization orientation of the second magnetic layer structure is configured to oscillate in a second direction in response to the current or the voltage applied across the magnetic junction so as to change the magnetization orientation of the free magnetic layer structure, the second direction being opposite to the first direction.

17. A magnetoresistive device having a magnetic junction, the magnetic junction comprising:

a first magnetic layer structure having a magnetization orientation, the first fixed magnetic layer structure comprising a first sub-layer and a second sub-layer;

a second magnetic layer structure having a magnetization orientation that is fixed or that is able to oscillate; and

a free magnetic layer structure having a variable magnetization orientation;

wherein the second magnetic layer structure is arranged on top of the free magnetic layer structure,

wherein the free magnetic layer structure is arranged on top of the first magnetic layer structure, in between the first magnetic layer structure and the second magnetic layer structure,

wherein the first sub-layer of the first magnetic layer structure, the second magnetic layer structure and the free magnetic layer structure have perpendicular anisotropy;

wherein the second sub-layer of the first magnetic layer structure has in-plane anisotropy;

wherein a magnetization orientation of the first sub-layer of the first magnetic layer structure and the magnetization orientation of the second magnetic layer structure are oriented in opposite directions;

wherein the magnetization orientation of the first sub-layer of the first magnetic layer structure is configured to oscillate in a first direction in response to a current or a voltage applied across the magnetic junction so as to change the magnetization orientation of the free magnetic layer structure; and

wherein the first magnetic layer structure comprises:

a ferromagnetic layer and a ferromagnetic hard layer the ferromagnetic layer defining the first sub-layer, and the ferromagnetic hard layer defining the second sub-layer;

wherein the ferromagnetic layer defining the first sub-layer is arranged on top of the ferromagnetic hard layer,

wherein the ferromagnetic layer defining the first sub-layer has perpendicular anisotropy,

wherein the magnetization orientation of the ferromagnetic layer defining the first sub-layer is configured to oscillate in the first direction in response to the current or the voltage applied across the magnetic junction; and

wherein the ferromagnetic hard layer has in-plane anisotropy.

18. A magnetoresistive device having a magnetic junction, the magnetic junction comprising:

a first magnetic layer structure having a magnetization orientation, the first magnetic layer structure comprising a first sub-layer and a second sub-layer;

a second magnetic layer structure having a magnetization orientation that is fixed or that is able to oscillate; and

a free magnetic layer structure having a variable magnetization orientation;

wherein the second magnetic layer structure is arranged on top of the free magnetic layer structure,

wherein the free magnetic layer structure is arranged on top of the first magnetic layer structure, in between the first magnetic layer structure and the second magnetic layer structure,

wherein the first sub-layer of the first magnetic layer structure, the second magnetic layer structure and the free magnetic layer structure have perpendicular anisotropy;

wherein the second sub-layer of the first magnetic layer structure has in-plane anisotropy;

wherein a magnetization orientation the first sub-layer of the first magnetic layer structure and the magnetization orientation of the second magnetic layer structure are oriented in opposite directions;

wherein the magnetization orientation of the first sub-layer of the first magnetic layer structure is configured to oscillate in a first direction in response to a current or a voltage applied across the magnetic junction so as to change the magnetization orientation of the free magnetic layer structure; and

wherein the first magnetic layer structure comprises:

a first ferromagnetic layer defining the first sub-layer;

a second ferromagnetic layer defining the second sub-layer; and

a ferromagnetic hard layer;

wherein the first ferromagnetic layer is arranged on top of the second ferromagnetic layer,

wherein the second ferromagnetic layer is arranged on top of the ferromagnetic hard layer, in between the first ferromagnetic layer and the ferromagnetic hard layer,

wherein the first ferromagnetic layer and the ferromagnetic hard layer have perpendicular anisotropy,

wherein the magnetization orientation of the first ferromagnetic layer is configured to oscillate in the first direction in response to the current or the voltage applied across the magnetic junction; and

wherein the second ferromagnetic layer has in-plane anisotropy.