## CLAIMS

1. A spin torque transfer magnetic random access memory (STT-MRAM) cell structure, comprising:

a nonmagnetic region having at least a first side, a second side parallel to the first side, and a third side perpendicular to each of the first side and the second side;

a first fixed region disposed directly along the first side of the nonmagnetic region;

a second fixed region disposed directly along the second side of the nonmagnetic region; and

a free region disposed along the third side of the nonmagnetic region.

2. The STT-MRAM cell structure of claim 1, wherein none of the free region, the first fixed region, or the second fixed region are in direct contact with one another.

3. The STT-MRAM cell structure of claim 1, comprising a top electrode disposed along the free region opposite the nonmagnetic region.

4. The STT-MRAM cell structure of claim 1, wherein the first fixed region is configured to be grounded such that a programming current through the free region to the nonmagnetic region and to the first fixed region results in electrons propagating from the first fixed region, through the nonmagnetic region, and through the free region to switch a

magnetization of the free region to be parallel with a magnetization of the first fixed region.

5. The STT-MRAM cell structure of claim 4, wherein the second fixed region is configured to be grounded such that a programming current driven through the free region to the nonmagnetic region and to the second fixed region results in electrons propagating from the second fixed region, through the nonmagnetic region, and through the free region to switch a magnetization of the free region to be antiparallel with a magnetization of the first fixed region.

6. The STT-MRAM cell structure of claim 1, comprising a tunnel barrier disposed between the free region and the nonmagnetic region.

7. The STT-MRAM cell structure of claim 1, comprising:

a first interface where the first fixed region contacts the nonmagnetic region, wherein electrons passing from the first fixed region through the first interface accumulate in the nonmagnetic region, wherein the passing electrons are spin polarized to a magnetization of the first fixed region; and

a second interface where the second fixed region contacts the nonmagnetic region, wherein electrons reflecting from the second fixed region into the nonmagnetic region accumulate in the nonmagnetic region, wherein the reflecting electrons are spin polarized

to a magnetization opposite of the second fixed region, and wherein the passing electrons and the reflecting electrons are spin polarized to a substantially similar direction.

8. A spin torque transfer magnetic random access memory (STT-MRAM) cell configured to be programmed by a unidirectional programming current, wherein the STT-MRAM cell comprises:

a first fixed region having a magnetization in a first direction;

a second fixed region having a magnetization in a second direction;

a nonmagnetic region directly between the first fixed region and the second fixed region; and

a free region disposed over the nonmagnetic region, wherein the free region is configured to be switched in magnetization by a unidirectional programming current to have a magnetization that is either parallel with or antiparallel to the magnetization of the first fixed region.

9. The STT-MRAM cell of claim 8, comprising a top electrode disposed over the free region on an opposite side of the free region from the nonmagnetic region.

10. The STT-MRAM cell of claim 9, comprising a transistor disposed over the top electrode.

11. The STT-MRAM cell of claim 8, wherein the first fixed region and the second fixed region are each configured to be either grounded or floating during an operation of the STT-MRAM cell.

12. The STT-MRAM cell of claim 8, wherein the free region is configured to be switched in magnetization when a programming current flows from a first side of the free region to a second side of the free region, wherein the first side of the free region is adjacent to the nonmagnetic region.

13. A spin torque transfer magnetic random access memory (STT-MRAM) cell configured for symmetrical programming, wherein the STT-MRAM cell comprises:

a first fixed region having a first magnetization;

a second fixed region having a second magnetization;

a nonmagnetic region disposed directly between the first fixed region and the second fixed region; and

a free region disposed over the nonmagnetic region, wherein the free region is configured to be switched by a first programming current to have the first magnetization or switched by a second programming current to have the second magnetization, wherein a magnitude of the first programming current is substantially similar to a magnitude of the second programming current.

14. The STT-MRAM cell of claim 13, wherein the first fixed region, the second fixed region, and the free region are not touching.

15. The STT-MRAM cell of claim 13, wherein the first fixed region, the second fixed region, and the free region each comprise Co, Fe, Ni or its alloys, NiFe, CoFe, CoNiFe, CoX, CoFeX, CoNiFeX (X= B, Cu, Re, Ru, Rh, Hf, Pd, Pt, C), $Fe_3O_4$, $CrO_2$, NiMnSb and PtMnSb, BiFeO, or any combination of the above materials.

16. The STT-MRAM cell of claim 13, wherein the nonmagnetic region comprises Cu, Au, Ta, Ag, CuPt, CuMn, $Al_xO_y$, $MgO_x$, $AlN_x$, $SiN_x$, $CaO_x$, $NiO_x$, $HfO_x$, $Ta_xO_y$, $ZrO_x$, $NiMnO_x$, $MgF_x$, SiC, $SiO_x$, $SiO_xN_y$, or any combination of the above materials.

17. The STT-MRAM cell of claim 13, wherein the nonmagnetic region is configured to transfer a spin filter effect to the free region.

18. The STT-MRAM cell of claim 13, wherein the first programming current and the second programming current are both unidirectional programming currents which propagate through the free region in one direction.

19. A method for forming a cell structure, the method comprising:

forming a recess in a substrate;

forming a transistor in the recess;

forming a free region in the recess and over the transistor;

forming a nonmagnetic region over the free region, such that the free region contacts a first side of the nonmagnetic region; and

forming a first fixed region and a second fixed region, such that the first fixed region directly contacts a second side of the nonmagnetic region and the second fixed region directly contacts a third side of the nonmagnetic region, wherein none of the free region, the first fixed region, or the second fixed region are touching.

20. The method of claim 19, comprising forming a top electrode over the transistor and forming the free region over the top electrode.

21. The method of claim 20, comprising forming a spacer region over the top electrode and depositing the free region within an inner perimeter of the spacer region.

22. The method of claim 19, comprising coupling a switch to ground either the first fixed region or the second fixed region.

## CLAIMS

1. A spin torque transfer magnetic random access memory (STT-MRAM) cell structure, comprising:

a nonmagnetic region having at least a first side, a second side, and a third side;

a first region with a fixed magnetization orientation disposed in direct contact with the first side of the nonmagnetic region;

a second region with a fixed magnetization orientation disposed in direct contact with the second side of the nonmagnetic region; and

a region with a free magnetization orientation disposed along the third side of the nonmagnetic region.

2. The STT-MRAM cell structure of claim 1, wherein none of the region with a free magnetization orientation, the first region with a fixed magnetization orientation, or the second region with a fixed magnetization orientation are in direct contact with one another.

3. The STT-MRAM cell structure of claim 1, comprising a top electrode disposed along the region with a free magnetization orientation opposite the nonmagnetic region.

4. A spin torque transfer magnetic random access memory (STT-MRAM) cell structure, comprising:

a nonmagnetic region having at least a first side, a second side, and a third side;

a first region with a fixed magnetization orientation disposed along the first side of the nonmagnetic region;

a second region with a fixed magnetization orientation disposed along the second side of the nonmagnetic region; and

a region with a free magnetization orientation disposed along the third side of the nonmagnetic region, wherein the first region with a fixed magnetization orientation is configured to be grounded such that a programming current through the region with a free magnetization orientation to the nonmagnetic region and to the first region with a fixed magnetization orientation results in electrons propagating from the first region with a fixed magnetization orientation, through the nonmagnetic region, and through the region with a free magnetization orientation to switch a magnetization of the region to be parallel with a magnetization of the first region with a fixed magnetization orientation.

5. The STT-MRAM cell structure of claim 4, wherein the second region with a fixed magnetization orientation is configured to be grounded such that a programming current driven through the region with a free magnetization orientation to the nonmagnetic region and to the second region with a fixed magnetization orientation results in electrons propagating from the second region with a fixed magnetization orientation, through the nonmagnetic region, and through the region with a free magnetization orientation to switch a magnetization of the region with a free magnetization orientation to be antiparallel with a magnetization of the first region with a fixed magnetization orientation.

6. The STT-MRAM cell structure of claim 1, comprising a tunnel barrier disposed between the region with a free magnetization orientation and the nonmagnetic region.

7. A spin torque transfer magnetic random access memory (STT-MRAM) cell structure, comprising:

a nonmagnetic region having at least a first side, a second side, and a third side;

a first region with a fixed magnetization orientation disposed along the first side of the nonmagnetic region;

a second region with a fixed magnetization orientation disposed along the second side of the nonmagnetic region; and

a region with a free magnetization orientation disposed along the third side of the nonmagnetic region;

a first interface where the first region with a fixed magnetization orientation contacts the nonmagnetic region, wherein electrons passing from the first region with a fixed magnetization orientation through the first interface accumulate in the nonmagnetic region, wherein the passing electrons are spin polarized to a magnetization of the first region with a fixed magnetization orientation; and

a second interface where the second region with a fixed magnetization orientation contacts the nonmagnetic region, wherein electrons reflecting from the second region with a fixed magnetization orientation into the nonmagnetic region accumulate in the nonmagnetic region, wherein the reflecting electrons are spin polarized to a magnetization opposite of the second region with a fixed magnetization orientation, and wherein the passing electrons and the reflecting electrons are spin polarized to a substantially similar direction.

8. A spin torque transfer magnetic random access memory (STT-MRAM) cell configured to be programmed by a unidirectional programming current, wherein the STT-MRAM cell comprises:

a first region with a fixed magnetization orientation having a magnetization in a first direction;

a second region with a fixed magnetization orientation having a magnetization in a second direction;

a nonmagnetic region between the first region with a fixed magnetization orientation and the second region with a fixed magnetization orientation; and

a region with a free magnetization orientation disposed over the nonmagnetic region, wherein the region with a free magnetization orientation is configured to be switched in magnetization by a unidirectional programming current to have a magnetization that is either parallel with or antiparallel to the magnetization of the first region with a fixed magnetization orientation.

9. The STT-MRAM cell of claim 8, comprising a top electrode disposed over the region with a free magnetization orientation on an opposite side of the region with a free magnetization orientation from the nonmagnetic region.

10. The STT-MRAM cell of claim 9, comprising a transistor disposed over the top electrode.

11. The STT-MRAM cell of claim 8, wherein the first region with a fixed magnetization orientation is grounded and the second region with a fixed magnetization orientation is floating in a first configuration, and the second region is grounded and the first region with a fixed magnetization orientation is floating in a second configuration.

12. The STT-MRAM cell of claim 8, wherein the region with a free magnetization orientation is configured to be switched in magnetization when a programming current flows from a first side of the region with a free magnetization orientation to a second side of the region with a free magnetization orientation, wherein the second side of the region with a free magnetization orientation is adjacent to the nonmagnetic region.

13. A spin torque transfer magnetic random access memory (STT-MRAM) cell configured for symmetrical programming, wherein the STT-MRAM cell comprises:

a first region with a fixed magnetization orientation having a first magnetization;

a second region with a fixed magnetization orientation having a second magnetization;

a nonmagnetic region disposed between the first region with a fixed magnetization orientation and the second region with a fixed magnetization orientation; and

a region with a free magnetization orientation disposed over the nonmagnetic region, wherein the region with a free magnetization orientation is configured to be switched by a first programming current to have the first magnetization or switched by a second programming current to have the second magnetization, wherein a magnitude of the first programming current is substantially similar to a magnitude of the second programming current.

14. The STT-MRAM cell of claim 13, wherein the first region with a fixed magnetization orientation, the second region with a fixed magnetization orientation, and the region with a free magnetization orientation are not touching.

15. The STT-MRAM cell of claim 13, wherein the first region with a fixed magnetization orientation, the second region with a fixed magnetization orientation, and the region with a free magnetization orientation each comprise Co, Fe, Ni or its alloys, NiFe, CoFe, CoNiFe, CoX, CoFeX, CoNiFeX (X=B, Cu, Re, Ru, Rh, Hf, Pd, Pt, C), $Fe_3O_4$, $CrO_2$, NiMnSb and PtMnSb, BiFeO, or any combination of the above materials.

16. The STT-MRAM cell of claim 13, wherein the nonmagnetic region comprises Cu, Au, Ta, Ag, CuPt, CuMn, $Al_xO_y$, $MgO_x$, $AlN_x$, $SiN_x$, $CaO_x$, $NiO_x$, $HfO_x$, $Ta_xO_y$, $ZrO_x$, $NiMnO_x$, $MgF_x$, SiC, $SiO_x$, $SiO_xN_y$, or any combination of the above materials.

17. The STT-MRAM cell of claim 13, wherein the nonmagnetic region is configured to transfer a spin filter effect to the region with a free magnetization orientation.

18. The STT-MRAM cell of claim 13, wherein the first programming current and the second programming current are both unidirectional programming currents which propagate through the region with a free magnetization orientation in one direction.

19. A method of operating a spin torque transfer magnetic random access memory (STT-MRAM) cell, the method comprising:

directing a first programming current to program the STT-MRAM cell in a first state, wherein the first programming current is directed through a region with a free magnetization orientation and through a second region with a fixed magnetization orientation having a second magnetization, such that electrons flowing from the second region with a fixed magnetization orientation are spin polarized to the second magnetization and switch a magnetization of the region with a free magnetization orientation to the second magnetization; and

directing a second programming current to program the STT-MRAM cell in a second state, wherein the second programming current is directed through the region with a free magnetization orientation and through a first region with a fixed magnetization orientation having a first magnetization, such that electrons flowing from the first region with a fixed magnetization orientation are spin polarized to the first magnetization and switch the magnetization of the region with a free magnetization orientation to the first magnetization, wherein the first programming current and the second programming current have a substantially similar magnitude and pass through the region with a free magnetization orientation in the same direction.

20. The method of operating the STT-MRAM cell of claim 19, comprising generating a spin filter effect in a nonmagnetic region between the first region with a fixed magnetization orientation and the second region with a fixed magnetization orientation, wherein the spin filter effect contributes to switching the magnetization of the region with a free magnetization orientation to either the first magnetization or the second magnetization.

21. The method of operating the STT-MRAM cell of claim 19, wherein switching the magnetization of the region with a free magnetization orientation to the first magnetization programs the STT-MRAM cell to a first memory state and switching the magnetization of the region with a free magnetization orientation to the second magnetization programs the STT-MRAM cell to a second memory state.

22. A method for forming a cell structure, the method comprising:

forming a recess in a substrate;

forming a transistor in the recess;

forming a region with a free magnetization orientation in the recess and over the transistor;

forming a nonmagnetic region over the region with a free magnetization orientation, such that the region with a free magnetization orientation contacts a first side of the nonmagnetic region; and

forming a first region with a fixed magnetization orientation and a second region with a fixed magnetization orientation, such that the first region with a fixed magnetization orientation directly contacts a second side of the nonmagnetic region and the second region with a fixed magnetization orientation directly contacts a third side of the nonmagnetic region, wherein none of the region with a free magnetization orientation, the first region with a fixed magnetization orientation, or the second region with a fixed magnetization orientation are touching.

23. The method of claim 22, comprising forming a top electrode over the transistor and forming

the region with a free magnetization orientation over the top electrode.

24. A method for forming a cell structure, the method comprising:

forming a recess in a substrate;

forming a transistor in the recess;

forming a region with a free magnetization orientation in the recess and over the transistor;

forming a nonmagnetic region over the region with a free magnetization orientation, such that the region with a free magnetization orientation contacts a first side of the nonmagnetic region;

forming a first region with a fixed magnetization orientation and a second region with a fixed magnetization orientation, such that the first region with a fixed magnetization orientation contacts a second side of the nonmagnetic region and the second region with a fixed magnetization orientation is adjacent to a third side of the nonmagnetic region, wherein none of the region with a free magnetization orientation, the first region with a fixed magnetization orientation, or the second region with a fixed magnetization orientation are touching;

forming a top electrode over the transistor and forming the region with a free magnetization orientation over the top electrode; and

forming a spacer region over the top electrode and depositing the region with a free magnetization orientation within an inner perimeter of the spacer region.

25. A method for forming a cell structure, the method comprising:

forming a recess in a substrate;

forming a transistor in the recess;

forming a region with a free magnetization orientation in the recess and over the transistor;

forming a nonmagnetic region over the region with a free magnetization orientation, such that the region with a free magnetization orientation contacts a first side of the nonmagnetic region;

forming a first region with a fixed magnetization orientation and a second region with a fixed magnetization orientation, such that the first region with a fixed magnetization orientation contacts a second side of the nonmagnetic region and the second region with a fixed magnetization orientation is adjacent to a third side of the nonmagnetic region, wherein none of the region with a free magnetization orientation, the first region with a fixed magnetization orientation, or the second region with a fixed magnetization orientation are touching; and

forming a switch to ground either the first region with a fixed magnetization orientation or the second region with a fixed magnetization orientation.