CLAIMS

What is claimed is:

1. A method of forming a diode structure, comprising:
forming a graphite material over a conductive material;
combining at least a portion of the graphite material with at least a portion of the conductive material to form a first electrode;
forming a dielectric material over the first electrode;
removing a portion of the dielectric material to form an opening exposing a surface of the first electrode;
forming a low-k dielectric material over surfaces of the opening;
forming a high-k dielectric material over the low-k dielectric material; and
filling a remaining portion of the opening with another conductive material to form a second electrode.

2. The method of claim 1, wherein forming a graphite material over a conductive material comprises forming graphene over the conductive material.

3. The method of claim 1, wherein forming a graphite material over a conductive material comprises forming a graphite material over at least one of nickel, cobalt, palladium, tungsten, platinum, and titanium nitride.

4. The method of claim 1, wherein combining at least a portion of the graphite material with at least a portion of the conductive material to form a first electrode comprises simultaneously forming the graphite material over the conductive material.

5. The method of claim 1, wherein forming a graphite material over a conductive material comprises exposing the conductive material to a carbon-containing precursor at a temperature of between about 600°C and about 650°C to form the first electrode comprising the graphite material and the conductive material.

6. The method of claim 1, wherein combining at least a portion of the graphite material with at least a portion of the conductive material to form a first electrode comprises exposing the at least a portion of the graphite material and the at least a portion of the conductive material to a temperature of between about 600°C and about 700°C to form the first electrode.

7. The method of claim 1, wherein removing a portion of the dielectric material to form an opening exposing a surface of the first electrode comprises removing a portion of the dielectric material to form an opening exposing a surface of a material comprising graphene and nickel.

8. The method of claim 1, wherein removing a portion of the dielectric material to form an opening exposing a surface of the first electrode comprises removing a portion of the dielectric material to form an opening exposing a surface of the graphite material overlying a material comprising the graphite material and the conductive material.

9. The method of claim 1, wherein combining at least a portion of the graphite material with at least a portion of the conductive material to form a first electrode comprises chemisorbing graphene onto the conductive material to form the first electrode.

10. The method of claim 9, wherein chemisorbing graphene onto the conductive material to form the first electrode comprises exposing the conductive material to a carbon-containing precursor at a temperature of less than about 700°C.

11. A method of forming a semiconductor device, comprising:

forming a plurality of diode structures, comprising:

chemisorbing at least a portion of a graphite material to a conductive material to form at least one first electrode;

forming a dielectric material over the at least one first electrode;

forming a low-k dielectric material in a plurality of openings in the dielectric material overlying the at least one first electrode;

forming a high-k dielectric material in the plurality of openings; and

forming another conductive material in the plurality of openings to form a plurality of second electrodes;

forming a plurality of resistors, each resistor adjacent one of the plurality of second electrodes; and

forming at least one conductive line over the plurality of resistors.

12. The method of claim 11, wherein chemisorbing at least a portion of a graphite material to a conductive material to form at least one first electrode comprises introducing a carbon-containing precursor to the conductive material to chemisorb graphene thereon.

13. The method of claim 11, wherein introducing a carbon-containing precursor to the conductive material comprises introducing at least one of acetylene, ethylene, and methane to the conductive material at a temperature of less than about 700°C.

14. The method of claim 11, wherein chemisorbing at least a portion of a graphite material to a conductive material to form at least one first electrode comprises:

depositing the graphite material over an underlying conductive material; and

annealing the graphite material and the conductive material.

15. A semiconductor device, comprising:

at least one memory cell disposed between at least one first conductive line and at least one second conductive line, the at least one memory cell comprising a resistor disposed adjacent a diode structure, the diode structure comprising:

a first electrode comprising a graphite material chemisorbed on a conductive material;

a low-k dielectric material overlying the first electrode; and

a high-k dielectric material disposed between the low-k dielectric and a second electrode.

16. The semiconductor device of claim 15, wherein the graphite material is located at an interface between the conductive material and the low-k dielectric material

17. The semiconductor structure of claim 15, wherein the graphite material comprises graphene.

18. The semiconductor structure of claim 15, wherein a work function of the first electrode is lower than a work function of the second electrode.

19. The semiconductor device of claim 15, wherein a difference between a work function of the first electrode and a work function of the second electrode is greater than or equal to about 1 eV.

20. The semiconductor structure of claim 15, wherein the first electrode has a work function of less than about 5 eV.

Claims:

1. A method of forming a diode structure, comprising:
chemisorbing at least a portion of a graphite material onto a conductive material to form a first electrode;
forming a dielectric material over the first electrode;
removing a portion of the dielectric material to form an opening exposing a surface of the first electrode;
forming a low-k dielectric material over surfaces of the opening;
forming a high-k dielectric material over the low-k dielectric material; and
filling a remaining portion of the opening with another conductive material to form a second electrode.

2. The method of claim 1, wherein chemisorbing at least a portion of a graphite material onto a conductive material comprises chemisorbing graphene onto the conductive material.

3. The method of claim 1, wherein chemisorbing at least a portion of a graphite material onto a conductive material comprises chemisorbing the at least a portion of the graphite material onto at least one of nickel, cobalt, palladium, tungsten, platinum, and titanium nitride.

4. The method of claim 1, wherein chemisorbing at least a portion of a graphite material onto a conductive material comprises forming the at least a portion of the graphite material over the conductive material while simultaneously combining the at least a portion of the graphite material with at least a portion of the conductive material.

5. The method of claim 1, wherein chemisorbing at least a portion of a graphite material onto a conductive material comprises exposing the conductive material to a carbon-containing precursor at a temperature of between about 600° C. and about 650° C.

6. The method of claim 1, wherein chemisorbing at least a portion of a graphite material onto a conductive material

comprises exposing the at least a portion of the graphite material and at least a portion of the conductive material to a temperature of between about 600° C. and about 700° C.

7. The method of claim **1**, wherein removing a portion of the dielectric material to form an opening exposing a surface of the first electrode comprises removing a portion of the dielectric material to form an opening exposing a surface of a material comprising graphene and nickel.

8. The method of claim **1**, wherein removing a portion of the dielectric material to form an opening exposing a surface of the first electrode comprises removing a portion of the dielectric material to form an opening exposing a surface of the at least a portion of the graphite material overlying a material comprising the at least a portion of the graphite material and the conductive material.

9. The method of claim **2**, wherein chemisorbing graphene onto the conductive material comprises chemisorbing the graphene onto nickel.

10. The method of claim **2**, wherein chemisorbing graphene onto the conductive material comprises exposing the conductive material to a carbon-containing precursor at a temperature of less than about 700° C.

11. The method of claim **1**, wherein forming a low-k dielectric material over surfaces of the opening comprises forming silicon dioxide over the dielectric material and the first electrode.

12. The method of claim **1**, wherein forming a high-k dielectric material over the low-k dielectric material comprises forming hafnium dioxide over the low-k dielectric material.

13. The method of claim **1**, further comprising removing portions of the low-k dielectric material, the high-k dielectric material and the another conductive material overlying the dielectric material to form the second electrode.

14. A method of forming a semiconductor device, comprising:

forming a plurality of diode structures, comprising:

chemisorbing at least a portion of a graphite material to a conductive material to form at least one first electrode;

forming a dielectric material over the at least one first electrode;

forming a low-k dielectric material in a plurality of openings in the dielectric material overlying the at least one first electrode;

forming a high-k dielectric material in the plurality of openings; and

forming another conductive material in the plurality of openings to form a plurality of second electrodes;

forming a plurality of resistors, each resistor adjacent one of the plurality of second electrodes; and

forming at least one conductive line over the plurality of resistors.

15. The method of claim **14**, wherein chemisorbing at least a portion of a graphite material to a conductive material to form at least one first electrode comprises introducing a carbon-containing precursor to the conductive material to chemisorb graphene thereon.

16. The method of claim **15**, wherein introducing a carbon-containing precursor to the conductive material comprises introducing at least one of acetylene, ethylene, and methane to the conductive material at a temperature of less than about 700° C.

17. The method of claim **14**, wherein chemisorbing at least a portion of a graphite material to a conductive material to form at least one first electrode comprises:

depositing the at least a portion of the graphite material over an underlying conductive material; and

annealing the at least a portion of the graphite material and the conductive material.

18. The method of claim **14**, wherein forming at least one conductive line over the plurality of resistors comprises forming a plurality of conductive lines in a direction perpendicular to a plurality of the first electrodes.

19. A semiconductor structure, comprising:

a first electrode comprising a graphite material chemisorbed on a conductive material;

a low-k dielectric material overlying the first electrode; and

a high-k dielectric material disposed between the low-k dielectric material and a second electrode.

20. The semiconductor structure of claim **19**, wherein the conductive material of the first electrode comprises at least one of nickel, cobalt, palladium, tungsten, platinum, and titanium nitride.

21. The semiconductor structure of claim **19**, wherein the graphite material comprises graphene.

22. The semiconductor structure of claim **21**, wherein the graphene chemisorbed on the conductive material comprises a complex of the graphene and nickel chemisorbed on a nickel material.

23. The semiconductor structure of claim **19**, wherein a work function of the first electrode is lower than a work function of the second electrode.

24. The semiconductor structure of claim **19**, wherein the first electrode has a work function of less than about 5 eV.

25. The semiconductor structure of claim **19**, wherein the second electrode comprises nickel.

26. The semiconductor structure of claim **19**, further comprising a resistor disposed adjacent the second electrode.

27. A semiconductor device, comprising:

a plurality of memory cells disposed between a plurality of first conductive lines and second conductive lines, each of the memory cells of the plurality comprising a resistor disposed adjacent a diode structure, the diode structure comprising:

a first electrode comprising a graphite material chemisorbed onto a conductive material;

a low-k dielectric material and a high-k dielectric material overlying the first electrode; and

a second electrode overlying the high-k dielectric material;

the graphite material located at an interface between the conductive material and the low-k dielectric material.

28. The semiconductor device of claim 27, wherein the first electrode comprises a portion of one of the first conductive lines of the plurality of first and second conductive lines.

29. The semiconductor device of claim 27, wherein each of the first conductive lines of the plurality of first and second conductive lines is disposed substantially perpendicular the second conductive lines of the plurality of first and second conductive lines.

30. The semiconductor device of claim 27, wherein the conductive material consists of nickel.

31. The semiconductor device of claim 27, wherein the graphite material comprises graphene chemisorbed to the conductive material of the first electrode.

32. The semiconductor device of claim 27, wherein a difference between a work function of the first electrode and a work function of the second electrode is greater than or equal to about 1 eV.