[0014] Accordingly, there remains a need in the art for a fixed cutter bit with a cutting structure capable of enhancing bit ROP, and bit durability. As such, embodiments disclosed herein address the requirement for improved thermal stability in PDC cutting elements, and further embodiments provide PDC cutting elements with characteristics to impart high abrasive resistance and high impact strength as compared to certain conventional cutters known in the art.

BRIEF SUMMARY OF THE DISCLOSED EMBODIMENTS

[0015] These and other needs in the art are addressed in one embodiment of the present disclosure~~invention~~ by a cutter element for a drill bit, comprising: a substrate having a longitudinal axis; a first layer of polycrystalline diamond coupled to the substrate; and a second layer of polycrystalline diamond coupled to the first layer at a first coherent boundary; wherein the first layer is axially positioned between the substrate and the second layer. In some embodiments the cutter element further comprising a third layer of polycrystalline diamond attached to the second layer at a second coherent boundary; wherein the second layer is axially positioned between the first layer and the third layer.

[0016] In some embodiments of the cutter element, the first layer has a first lattice constant; the second layer has a second lattice constant; whereby the second lattice constant is different from the first lattice constant. In some further embodiments of the cutter element, the third layer has a third lattice constant, wherein the third lattice constant is different from the second lattice constant. In other embodiments of the cutter element, the difference between the first and the second lattice constant is less that 10%, and in some further embodiments the difference between the second and the third lattice constant is less that 10%.

[0016a] In one aspect, there is provided a cutter element for a drill bit, comprising: a substrate having a longitudinal axis; a first layer of polycrystalline diamond coupled to the substrate; and a second layer of polycrystalline diamond coupled to the first layer at a first coherent boundary; wherein the first layer is axially positioned between the substrate and the second layer, and wherein the first layer has a first lattice constant; the second layer has a second lattice constant; whereby the second lattice constant is different from the first lattice constant wherein the difference between the first lattice constant and the second lattice constant is less than 10%.

[0016b] Another aspect relates to a method of applying polycrystalline diamond layers on a substrate, comprising: (a) loading a container with a first volume of polycrystalline diamond material with a first lattice constant; (b) loading the container with at a second volume of polycrystalline diamond material with a second lattice constant, after (a), wherein said second lattice constant is different from said first lattice constant; (c) loading a volume of a substrate material after (b); (d) sintering each said volume of material by applying high temperature and high pressure; and (e) forming a first coherent boundary between said first volume and said second volume.

[0016c] Another aspect relates to a drill bit for drilling a borehole in earthen formations, the bit comprising: a plurality of cutter elements mounted on the bit, wherein said cutter elements comprise: a substrate having a longitudinal axis; a first layer of polycrystalline diamond coupled to the substrate; a second layer of polycrystalline diamond coupled to said first layer at a first coherent boundary; wherein the first layer is axially positioned between the substrate and the second layer, and wherein the first layer has a first lattice constant; the second layer has a second lattice constant; whereby the second lattice constant is different from the first lattice constant and wherein the difference between the first lattice constant and the second lattice constant is less than 10%.

[0017] In embodiments of the cutter element, the first layer has a first particle size; the second layer has a second particle size; whereby the second particle size is different from the first particle size. In some further embodiments, the third layer has a third particle size; whereby the third particle size is different from the second particle size.

[0018] In some other embodiments of the cutter element, at least one said layer is doped with a dopant selected from the group consisting of Al, B, N, Ti, P, and Zr. In some further embodiments, the layer is doped in an amount of about 0.01 atomic percent to about 10 atomic percent of said dopant, in still further embodiments the layer is doped with B. and in some embodiments B is in an amount of less than about 0.5 atomic percent.

[0019] One embodiment is drawn to a method of applying polycrystalline diamond layers on a substrate, comprising: loading a container with a first volume of polycrystalline diamond material with a first lattice constant; loading the container with at a second volume of polycrystalline diamond material with a second lattice constant, wherein said second lattice

CLAIMS

What is claimed is:

1. A cutter element for a drill bit, comprising:

a substrate having a longitudinal axis;

a first layer of polycrystalline diamond coupled to the substrate; and

a second layer of polycrystalline diamond coupled to the first layer at a first coherent boundary; wherein the first layer is axially positioned between the substrate and the second layer, and wherein the first layer has a first lattice constant; the second layer has a second lattice constant; whereby the second lattice constant is different from the first lattice constant wherein the difference between the first lattice constant and the second lattice constant is less than 10%.

2. The cutter element of claim 1, further comprising a third layer of polycrystalline diamond attached to the second layer at a second coherent boundary; wherein the second layer is axially positioned between the first layer and the third layer.

3. The cutter element of claim 2, wherein said third layer has a third lattice constant, wherein the third lattice constant is different from the second lattice constant.

~~4. The cutter element of claim 1, wherein the difference between the first and the second lattice constant is less that 10%.~~

~~5.~~4. The cutter element of claim 3, wherein the difference between the second and the third lattice constant is less than~~n~~ 10%.

~~6.~~5. The cutter element of claim 1, wherein the first layer has a first particle size; the second layer has a second particle size; whereby the second particle size is different from the first particle size.

~~7.~~6. The cutter element of claim 2, wherein the third layer has a third particle size; whereby the third particle size is different from the second particle size.

~~8.~~7. The cutter element of claim 1, wherein at least one said layer is doped with a dopant selected from the group consisting of Al, B, N, Ti, P, and Zr.

~~9.~~8. The cutter element of claim 2, wherein at least one said layer is doped with a dopant selected from the group consisting of Al, B, N, Ti, P, and Zr.

~~10.~~9. The cutter element of claim ~~8~~7, wherein the layer is doped in an amount of about 0.01 atomic percent to about 10 atomic percent of said dopant.

~~11.~~10. The cutter element of claim ~~8~~7, wherein said layer is doped with B.

~~12.~~11. The cutter element of claim ~~11~~10, wherein B is in an amount of less than about 0.5 atomic percent.

~~13.~~12. The cutter element of claim ~~9~~8, wherein the layer is doped in an amount of about 0.01 atomic percent to about 10 atomic percent of said dopant.

~~14.~~13. The cutter element of claim ~~9~~8, wherein said layer is doped with B.

~~15.~~14. The cutter element of claim 143, wherein B is in an amount of less than about 0.5 atomic percent.

~~16.~~15. A method of applying polycrystalline diamond layers on a substrate, comprising:

(a) loading a container with a first volume of polycrystalline diamond material with a first lattice constant;

(b) loading the container with at a second volume of polycrystalline diamond material with a second lattice constant, after (a), wherein said second lattice constant is different from said first lattice constant;

(c) loading a volume of a substrate material after (b);

(d) sintering each said volume of material by applying high temperature and high pressure; and

(e) forming a first coherent boundary between said first volume and said second volume.

~~17.~~16. The method of claim ~~16~~15, further comprising: loading said container with a third volume of polycrystalline diamond material with a third lattice constant, after (b) and before (c), wherein said third lattice constant is different to said second lattice constant; and forming a second coherent boundary between said second volume and said third volume.

~~18.~~17. The method of claim ~~16~~15, wherein said loading is by chemical vapor deposition.

~~19.~~18. The method of claim ~~16~~15, wherein said loading is by solid state liquid diffusion.

~~20.~~19. The method of claim ~~16~~ 15 wherein said high temperature is a temperature greater than about 1,200K.

~~21.~~20. The method of claim ~~16~~ 15 wherein said high pressure is a pressure greater than about 7 Gpa.

~~22.~~21. The method of claim ~~17~~16, wherein said loading is by chemical vapor deposition.

~~23.~~22. The method of claim ~~17~~16, wherein said loading is by solid state diffusion.

~~24.~~23. The method of claim ~~17~~16, wherein said high temperature is a temperature greater than about 1,200K.

~~25.~~24. The method of claim ~~17~~16, wherein said high pressure is a pressure greater than about 7 Gpa.

~~26.~~25. A drill bit for drilling a borehole in earthen formations, the bit comprising:

a plurality of cutter elements mounted on the bit, wherein said cutter elements comprise:

a substrate having a longitudinal axis;

a first layer of polycrystalline diamond coupled to the substrate;

a second layer of polycrystalline diamond coupled to said first layer at a first coherent boundary; wherein the first layer is axially positioned between the substrate and the second layer, and wherein the first layer has a first lattice constant; the second layer has a second lattice constant; whereby the second lattice constant is different from the first lattice constant and wherein the difference between the first lattice constant and the second lattice constant is less than 10%.

~~27~~26. The drill bit of claim ~~26~~25, wherein said cutter elements further comprise a third layer of polycrystalline diamond coupled to the second layer at a second coherent boundary; wherein the second layer is axially positioned between the first layer and the third layer.