CLAIMS

What is claimed is:

1. An instrumented cutting element for use on an earth-boring tool, comprising:

a substrate;

a diamond table bonded to the substrate; and

at least one sensing element disposed at least partially within the diamond table, the at least one sensing element comprising a doped diamond material.

2. The instrumented cutting element of claim 1, wherein the doped diamond material includes polycrystalline diamond and a dopant selected from the group consisting of boron, phosphorus, and sulfur.

3. The instrumented cutting element of claim 1, wherein the doped diamond material is embedded within the diamond table.

4. The instrumented cutting element of claim 1, wherein the doped diamond material extends through a thickness of the diamond table.

5. The instrumented cutting element of claim 1, wherein the substrate comprises at least one conduit coupled with the at least one sensing element, the at least one conduit configured to transmit an electrical signal away from the at least one sensing element.

6. The instrumented cutting element of claim 5, wherein the at least one conduit comprises an electrical conductor.

7. The instrumented cutting element of claim 1, further comprising an electrical contact coupled with the substrate on a surface opposite the diamond table.

8. The instrumented cutting element of claim 1, wherein the doped diamond material is formed in one of an annular shape, a linear shape, and a rectangular shape.

9. The instrumented cutting element of claim 1, wherein the at least one sensing element includes a plurality of sensing elements each comprising a doped diamond material disposed at least partially within the diamond table.

10. The instrumented cutting element of claim 9, wherein the sensing elements of the plurality of sensing elements are concentrically arranged.

11. The instrumented cutting element of claim 1, wherein the diamond table comprises polycrystalline diamond including inter-bonded diamond grains with interstitial spaces between the inter-bonded diamond grains, at least a portion of the interstitial spaces being at least substantially free of metal solvent catalyst material.

12. An earth-boring tool, comprising:

a tool body; and

an instrumented cutting element attached to the tool body, the instrumented cutting element including a substrate, a diamond table bonded to the substrate, and at least one sensing element disposed at least partially within the diamond table, the at least one sensing element comprising a doped diamond material.

13. The earth-boring tool of claim 12, wherein the earth-boring tool comprises an earth-boring rotary drill bit.

14. The earth-boring tool of claim 12, wherein the doped diamond material includes polycrystalline diamond and a dopant selected from the group consisting of boron, phosphorus, and sulfur.

15. A method for obtaining a measurement at an earth-boring tool, the method comprising receiving an electrical signal from a doped diamond material disposed at least partially within a diamond table of an instrumented cutting element attached to the earth-boring tool.

16. The method of claim 15, wherein receiving the electrical signal includes receiving the electrical signal through a conduit extending through a substrate of the instrumented cutting element.

17. The method of claim 15, further comprising correlating the electrical signal with at least one parameter during a drilling operation.

18. The method of claim 17, wherein correlating the electrical signal with at least one parameter includes correlating a characteristic of a subterranean formation with the electrical signal.

19. The method of claim 17, wherein correlating the electrical signal with at least one parameter includes correlating a characteristic of the instrumented cutting element with the electrical signal.

20. The method of claim 17, further comprising actively controlling the drilling operation responsive to data derived from the electrical signal.

Claims

1. An instrumented cutting element for use on an earth-boring tool, the instrumented cutting element comprising:

a substrate;

a diamond table bonded to the substrate;

at least one sensing element disposed at least partially within the diamond table, the at least one sensing element comprising a doped diamond material, wherein the substrate comprises at least one conduit coupled and at least partially aligned with the at least one sensing element and extending at least substantially through the substrate; and

wherein the at least one conduit comprises an electrical conductor configured to transmit an electrical signal away from the at least one sensing element.

2. The instrumented cutting element of claim 1, wherein the doped diamond material includes polycrystalline diamond and a dopant selected from the group consisting of boron, phosphorus, and sulfur.

3. The instrumented cutting element of claim 1, wherein the doped diamond material is embedded within the diamond table.

4. The instrumented cutting element of claim 1, wherein the doped diamond material extends through a thickness of the diamond table.

5. The instrumented cutting element of claim 1, wherein the at least one conduit further comprises a dielectric material surrounding the electrical conductor and isolating the electrical conductor from the substrate.

6. The instrumented cutting element of claim 1, further comprising an electrical contact coupled with the substrate on a surface opposite the diamond table.

7. The instrumented cutting element of claim 1, wherein the doped diamond material is formed in one of an annular shape, a linear shape, and a rectangular shape.

8. The instrumented cutting element of claim 1, wherein the at least one sensing element includes a plurality of sensing elements each comprising a doped diamond material disposed at least partially within the diamond table.

9. The instrumented cutting element of claim 8, wherein the sensing elements of the plurality of sensing elements are concentrically arranged.

10. The instrumented cutting element of claim 1, wherein the diamond table comprises polycrystalline diamond including inter-bonded diamond grains with interstitial spaces between the inter-bonded diamond grains, at least a portion of the interstitial spaces being at least substantially free of metal solvent catalyst material.

11. An earth-boring tool, comprising:

a tool body; and

an instrumented cutting element attached to the tool body, the instrumented cutting element comprising:

a substrate;

a diamond table bonded to the substrate;

at least one sensing element disposed at least partially within the diamond table, the at least one sensing element comprising a doped diamond material, wherein the substrate comprises at least one conduit coupled and at least partially aligned with the at least one sensing element and extending at least substantially through the substrate; and

wherein the at least one conduit comprises an electrical conductor configured to transmit an electrical signal away from the at least one sensing element.

12. The earth-boring tool of claim 11, wherein the earth-boring tool comprises an earth-boring rotary drill bit.

13. The earth-boring tool of claim 11, wherein the doped diamond material includes polycrystalline diamond and a dopant selected from the group consisting of boron, phosphorus, and sulfur.

14. A method for obtaining a measurement at an earth-boring tool, the method comprising receiving an electrical signal through a conduit extending at least substantially through a substrate of the instrumented cutting element from a doped diamond material disposed at least partially within a diamond table of the instrumented cutting element attached to the earth-boring tool; and

correlating the electrical signal with at least one parameter during a drilling operation, wherein the correlating the electrical signal with at least one parameter includes correlating a characteristic of a subterranean formation with the electrical signal.

15. The method of claim 14, wherein correlating the electrical signal with at least one parameter includes correlating a characteristic of the instrumented cutting element with the electrical signal.

16. The method of claim 14, further comprising actively controlling the drilling operation responsive to data derived from the electrical signal.

17. The instrumented cutting element of claim 1, wherein the at least one sensing element comprises two or more sensing elements and the at least one conduit comprises two or more conduits, wherein each conduit of the two or more conduits is coupled and at least partially aligned with a respective sensing element of the two or more sensing elements.