Title: SILICON CARBIDE COMPOSITE MATERIALS, EARTH-BORING TOOLS COMPRISING SUCH MATERIALS, AND METHODS FOR FORMING THE SAME

Abstract: Earth-boring tools for drilling subterranean formations include a particle-matrix composite material comprising a plurality of silicon carbide particles dispersed throughout a matrix material, such as, for example, an aluminum or aluminum-based alloy. In some embodiments, the silicon carbide particles comprise an ABC-SiC material. Methods of manufacturing such tools include providing a plurality of silicon carbide particles within a matrix material. Optionally, the silicon carbide particles may comprise ABC-SiC material, and the ABC-SiC material may be toughened to increase a fracture toughness exhibited by the ABC-SiC material. In some methods, at least one of an infiltration process and a powder compaction and consolidation process may be employed.
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What is claimed is:

1. An earth-boring tool for drilling subterranean formations, the tool comprising:
   a bit body including a crown region comprising a particle-matrix composite material,
   the composite material comprising a plurality of ABC-SiC particles dispersed
   throughout an aluminum or an aluminum-based alloy matrix material; and
   at least one cutting structure disposed on a face of the bit body.

2. The earth-boring tool of claim 1, wherein the plurality of ABC-SiC particles comprises between about 40% and about 70% by weight of the particle-matrix composite material, and wherein the aluminum or aluminum-based
alloy matrix material comprises between about 30% and about 60% by weight of the particle-matrix composite material.

3. The earth-boring tool of claim 1 or claim 2, wherein the aluminum or aluminum-based alloy matrix material of the composite material comprises at least
   75% by weight aluminum and at least trace amounts of at least one of boron, carbon, copper, iron, lithium, magnesium, manganese, nickel, scandium, silicon, tin, zirconium, and zinc.

4. The earth-boring tool of any one of claims 1 through 3, wherein the
   aluminum or aluminum-based alloy matrix material of the composite material
   comprises at least one discontinuous precipitate phase dispersed through a continuous phase comprising a solid solution.

5. The earth-boring tool of any one of claims 1 through 4, wherein the
   plurality of ABC-SiC particles comprises a toughened ABC-SiC material exhibiting
   a fracture toughness greater than about 5 MPa-m$^{1/2}$.
6. A method of forming an earth-boring tool, the method comprising:
providing a plurality of ABC-SiC particles in a matrix material to form a body; and
shaping the body to form at least a portion of an earth-boring tool for drilling
subterranean formations.

7. The method of claim 6, wherein providing a plurality of ABC-SiC particles in a matrix material to form a body comprises:
melting the matrix material;
infiltrating the plurality of ABC-SiC particles with the molten matrix material within
a cavity of a mold; and
cooling and solidifying the matrix material in the cavity of the mold.

8. The method of claim 7, further comprising heat treating the matrix
material to increase the hardness of the matrix material.

9. The method of claim 8, wherein heat treating the matrix material
comprises:
cooling the matrix material to form a solid solution; and
forming at least one discontinuous precipitate phase within the solid solution, the at
least one discontinuous precipitate phase causing the solid matrix material to
exhibit a bulk hardness that is harder than a bulk hardness of the solid solution.
10. The method of claim 6, wherein providing a plurality of ABC-SiC particles in a matrix material to form a body comprises:

providing a green powder component comprising:

the plurality of ABC-SiC particles; and

a plurality of particles each comprising the matrix material, the matrix material comprising an aluminum or an aluminum-based alloy material; and

at least partially sintering the green powder component.

11. The method of claim 10, wherein providing a green powder component comprises:

providing a powder mixture comprising:

the plurality of ABC-SiC particles;

the plurality of particles each comprising the matrix material; and

a binder material; and

pressing the powder mixture.

12. The method of claim 10 or claim 11, wherein at least partially sintering the green powder component comprises:

partially sintering the green powder component to form a brown bit body;

machining at least one feature in a surface of the brown bit body; and

sintering the brown bit body to a desired final density.

13. The method of any one of claims 6 through 12, further comprising toughening the ABC-SiC particles, wherein toughening the ABC-SiC particles comprises:

annealing at least one compact comprising ABC-SiC material to alter at least one of a size and a shape of SiC grains within the at least one compact; and

breaking apart the at least one compact to form the plurality of ABC-SiC particles.

14. The method of any one of claims 6 through 12, wherein providing a
plurality of ABC-SiC particles in a matrix material to form a body comprises:
consolidating ABC-SiC material to form at least one compact; and
breaking apart the at least one compact to form the plurality of ABC-SiC particles.

15. The method of claim 14, further comprising annealing the ABC-SiC material of the compact to increase a fracture toughness exhibited by the ABC-SiC material.

16. The method of any one of claims 6 through 15, further comprising selecting the matrix material to comprise at least 75% by weight aluminum and at least trace amounts of at least one of boron, carbon, copper, iron, lithium, magnesium, manganese, nickel, scandium, silicon, tin, zirconium, and zinc.

17. The method of any one of claims 6 through 16, wherein shaping the body to form at least a portion of an earth-boring tool for drilling subterranean formations comprises shaping the body to form at least a portion of a bit body of an earth-boring rotary drill bit.

18. The method of claim 17, further comprising:
providing a shank that is configured for attachment to a drill string; and
attaching the shank to the earth-boring rotary drill bit.
STATEMENT UNDER ARTICLE 19(1) (RULE 46.4)

Dear Examiner Jung:

Applicant has amended claims 1, 2, 6 through 13, and 15 through 20 and claims 5 and 14 have been cancelled. The amendments to the claims are more fully described in the Letter Accompanying the Article 19 Amendments, which is also submitted herewith. The amendments have no impact on the description and the drawings.

Very truly yours,

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