CLAIMS

1. A method of continuous 3D printing to print an article, comprising:

displacing a nozzle of a 3D printer along a nozzle displacement direction at a nozzle velocity;

concurrent with the displacing of the nozzle, extruding an ink from the nozzle to form an extrudate on a porous base, the ink including a plurality of magnetically responsive particles and a rheological modifier in an acqueous solution;

concurrent with the displacing of the nozzle, displacing a rotating magnetic field along the nozzle displacement direction to perform a step of magnetic alignment of the magnetically responsive particles in the extrudate;

after the step of magnetic alignment, a step of jamming the magnetically responsive particles in the extrudate; and

after the step of jamming, a step of drying the extrudate.

2. The method according to claim 1, comprising:

rotating a magnet relative to the nozzle to provide the rotating magnetic field, the magnet being disposed proximal to the nozzle; and

concurrently displacing the magnet and the nozzle along the nozzle displacement direction at the nozzle velocity.

3. The method according to claim 1 or claim 2, wherein the rotating magnetic field is characterized by a rotating speed higher than 1 Hertz.

4. The method according to any one of claims 1 to 3, wherein the ink comprises fumed silica nanoparticles in an aqueous solution.

5. The method according to any one of claims 1 to 3, wherein the extrudate undergoes the following changes in sequence:

(i) the step of magnetic alignment over a time of magnetic alignment;

(ii) the step of jamming over a time of jamming; and

(iii) the step of drying over a time of drying, wherein a concentration of the magnetically responsive particles in the extrudate after the time of drying is higher than the concentration of the magnetically responsive particles in the extrudate before the time of magnetic alignment.

6. The method according to claim 4, wherein the step of magnetic alignment comprises aligning of the magnetically responsive particles in the extrudate proximal to the nozzle, wherein the aligning is in response to the magnetic field.

7. The method according to any one of claims 4 to 6 wherein the magnetically responsive particles are microparticles.

8. The method according to any one of claims 5 to 7, wherein the step of jamming comprises similarly oriented ones of the magnetically responsive particles packing themselves more closely together as water is lost from the extrudate.

9. The method according to claim 8, wherein water is lost from the extrudate at least partially by the water being drawn by capillary action of the porous base.

10. The method according to any one of claims 5 to 9, wherein the step of drying comprises a loss of water from the extrudate distal to the nozzle.

11. The method according to any one of claims 1 to 10, further comprising a step of sintering the article.

12. The method according to any one of claims 1 to 11, further comprising determining a composition of the ink based on time-based parameters and a viscosity of the ink within a range of printable and orientable viscosities, wherein the ink includes magnetically responsive particles that are alignable in any one of two directions, in response to the magnetic field.

13. The method according to claim 12, wherein the ink is characterized by a yield stress smaller than 45 Pa.

14. The method according to claim 12, wl 29 the magnetically responsive particles comprise superparamagnetic iron oxide nanoparticles adsorbed on alumina microplatelets, and wherein the ink comprises Al_2O_3 microplatelets with 14 vol% superparamagnetic iron oxide nanoparticles adsorbed thereon, 4 wt% SiO_2, and water, and wherein the ink is characterized by a viscosity of less than 1000 Pa·s and a yield stress of less than 45 Pa.

15. The method according to claim 12, wherein the ink comprises 10 wt% of graphite microplatelets with superparamagnetic iron oxide nanoparticles adsorbed thereon, 4 wt% SiO_2, and water, and wherein the ink is characterized with a viscosity of 78 Pa·s and a yield stress of 2.5 Pa.