CLAIMS

1. A composition useful in forming a structure comprising an interconnected vascular network, the composition comprising a powder including a carbohydrate powder or a carbohydrate-derived powder, wherein the powder:

   has a granular form, and

   is configured to be a free-flowing powder having a specific energy (mJ/g) multiplied by the powder's conditioned bulk density (g/mL) of less than 6 millijoules per milliliter (mJ/mL).

2. The composition of claim 1, wherein the carbohydrate powder comprises at least one of agarose, gelatin, sucrose, glucose, fructose, lactose, dextran, isomalt, cellulose, methylcellulose, poly(lactic acid), or poly(ethylene glycol).

3. The composition of claim 1, wherein the composition further comprises

   an anti-caking agent.

4. The composition of any one of claims 1-3, wherein:

   the powder has a maximum particle size of 250 micrometers (μm) or less.

5. A three-dimensional structure obtained by a method of forming an interconnected vascular network, the method comprising:

fusing the composition of any one of claims 1-3 with an energy beam to form a solidified filament network; wherein

   the filament network comprises a plurality of filaments and defines a void space;

   backfilling the void space of the filament network with a matrix material, wherein the matrix material is an aqueous solution comprising a biomaterial; and

   removing the filaments to form the interconnected vascular network comprising fluidic channels, and

crosslinking the biomaterial to form a hydrogel in the void space.

6. The three-dimensional structure of claim 5, further comprising a surface coating on the filament network.

7. The three-dimensional structure of claim 5, wherein the powder has been fused together into a solid, contiguous filament using a laser.

8. The three-dimensional structure of Claim 5, wherein the powder has been fused together into a solid, filament network using a laser.

9. The three-dimensional structure of claim 5, wherein the filament network has undergone a surface smoothing using a smoothing solution.
10. The three-dimensional structure of claim 9, wherein the filament network has been subsequently coated with a surface coating material.
11. A structure comprising an interconnected vascular network, comprising:
    a matrix material; and
    a structural material disposed through matrix material; wherein
        the structural material is configured to provide the three-dimensional structure of claim 5; and
        the matrix material is a crosslinked biomaterial, and the biomaterial comprises at least one of polyamide, poly(2-hydroxy ethyl methacrylate), poly(vinyl alcohol), polyacrylamide, poly(ethylene glycol), a polyurethane, collagen, agarose, albumin, alginate, chitosan, starch, hyaluronic acid, gelatin, fibrin, matrigel, glycerol, glycol, mannitol, inositol, xylitol, adonitol, glycine, arginine, biological polymeric molecules, or peptide amphiphiles, or monomers, dimers, or oligomers thereof.
12. The structure of claim 11, wherein the powder has been fused together into a solid, contiguous filament using a laser.
13. The structure of claim 11, wherein the powder has been fused together into a solid, contiguous three-dimensional filament network using a laser.
14. The structure of claim 11, wherein a surface of the three-dimensional structure has undergone a surface smoothing.
15. The structure of claim 11, wherein the powder comprises at least one of dextran or isomalt.
16. The structure of claim 11, wherein
    the powder comprises at least one of agarose, gelatin, sucrose, glucose, fructose, lactose, isomalt, dextran, cellulose, methylcellulose, poly(lactic acid), or poly(ethylene glycol).
17. The structure of claim 11, wherein
    the anti-caking agent comprises one or more materials that improve at least one of flow, friction characteristics, or particle packing of the structural material.
18. The structure of claim 17, wherein
    the anti-caking agent comprises at least one of cornstarch, silicon dioxide, or xanthan gum.

19. The structure of claim 11, wherein a particle size of the powder is 250 μm diameter or less.
20. The structure of claim 11, wherein a surface of the structural material is coated by a surface coating material.
21. The structure of claim 20, wherein
    the surface coating material comprises at least one of polycaprolactone, poly(L-lactide), polylactic acid, poly(lactic co-glycolic acid), collagen, gelatin, zein, shellac, starch, wax, or petroleum jelly.
22. The structure of claim11,
    wherein the powder is configured to be a free-flowing powder.
23. A method of forming an interconnected vascular network, comprising:
    fusing the composition of any one of claims 1-3 with an energy beam to form a solidified filament network; wherein
        the filament network comprises a plurality of filaments and defines a void space;
    backfilling the void space of the filament network with a matrix material, wherein the matrix material is an aqueous solution comprising a biomaterial; and
    removing the filaments to form the interconnected vascular network comprising fluidic channels, and
    crosslinking the biomaterial to form a hydrogel in the void space.
24. The method of claim 23, wherein
    the energy beam is a laser.
25. The method of claim 23, wherein
    the powder comprises a carbohydrate powder and an anti-caking agent, wherein the powder:
        has a granular form, and
        has a specific energy (mJ/g) multiplied by the powder's conditioned bulk density (g/mL) of less than 6 mJ/mL, and
    the energy beam is a laser.
26. The method of claim 23, further comprising:
    surface smoothing the plurality of filaments with a smoothing solution, wherein
        the surface smoothing otherwise does not alter an architecture of the filaments.
27. The method of claim 26, wherein

the smoothing solution comprises at least one of isomalt, dextran, sucrose, glucose, lactose, trehalose, maple syrup, or sugar cane syrup.

28. The method of claim 23, further comprising:

surface coating the plurality of filaments with a surface coating material, wherein:

the surface coating material does not backfill the void space, and

the matrix material and the surface coating material are different materials.

29. The method of claim 28, wherein

the surface coating material comprises at least one of polycaprolactone, poly(L-lactide), polylactic acid, poly(lactic co-glycolic acid), collagen, gelatin, zein, shellac, a starch, wax, or petroleum jelly.

30. The method of claim 23, wherein the filament network is disposed in a three-dimensionally branched pattern.

31. The method of claim 23, wherein the filament network is entangled.

32. The method of claim 23, wherein the filaments are configured during fabrication as unsupported overhangs or underhangs.

33. The method of claim 23, wherein removing the filaments is performed by dissolution or degradation.

34. The method of claim 23, wherein the aqueous solution further comprises a suspension of living cells and wherein the step of removing the filaments does not damage the living cells.

35. The method of claim 23, wherein

the matrix material is a crosslinked biomaterial, and the biomaterial comprises at least one of polyamide, poly(2-hydroxy ethyl methacrylate), poly(vinyl alcohol), polyacrylamide, poly(ethylene glycol), a polyurethane, collagen, agarose, albumin, alginate, chitosan, starch, hyaluronic acid, gelatin, fibrin, matrigel, glycerol, glycol, mannitol, inositol, xylitol, adonitol, glycine, arginine, biological polymeric molecules, or peptide amphiphiles, or monomers, dimers, or oligomers thereof.

36. The method of claim 23, wherein:

the powder is configured to be a free-flowing powder, and

the powder has a maximum particle size of 250 μm or less.

37. The composition of claim 2, wherein the powder comprises at least one of agarose, sucrose, glucose, fructose, lactose, isomalt, dextran, cellulose, or methylcellulose.

38. The composition of claim 37, wherein the powder comprises at least one of dextran

or isomalt.

39. The composition of claim 3, wherein the anti-caking agent comprises at least one of cornstarch, silicon dioxide, or xanthan gum.

40. The composition of claim 39, wherein the anti-caking agent comprises cornstarch.

41. The composition of claim 1, wherein:

the powder comprises at least one of agarose, gelatin, sucrose, glucose, fructose, lactose, isomalt, dextran, cellulose, methylcellulose, poly(lactic acid), or poly(ethylene glycol), and

the composition further comprises an anti-caking agent.

42. The composition of claim 41, wherein:

the powder comprises at least one of dextran or isomalt, and

the anti-caking agent comprises cornstarch.