Claims

1. A polishing pad, comprising:

a continuous polymer phase of polishing pad material which forms a polishing surface of the polishing pad, comprising:

one or more first material domains formed of a polymerized reaction product of a first pre-polymer composition; and

a plurality of second material domains formed of a polymerized reaction product of a second pre-polymer composition, wherein

the second pre-polymer composition is different from the first pre-polymer composition,

interfacial regions between the one or more first material domains and the plurality of second material comprise a co-polymerized reaction product of the first pre-polymer composition and the second pre-polymer composition,

the plurality of second material domains are distributed in a pattern in the continuous polymer phase of polishing pad material, the pattern comprising:

(a) the plurality of second material domains disposed in a side-by-side arrangement with the one or more first material domains in an X-Y plane of the continuous polymer phase of polishing pad material, wherein at least one lateral dimension of one or more of the plurality second material domains is less than 10 mm when measured in the X-Y plane;

(b) the plurality of second material domains disposed in an alternating stacked arrangement with the one or more first material domains in a Z plane of the continuous polymer phase of polishing pad material, wherein at least one dimension of one or more of the plurality of second material domains is less than 1 mm when measured in the Z plane; or

c) a combination of (a) and (b),

the X-Y plane is parallel to a supporting surface of the polishing pad,

the Z plane is orthogonal to the X-Y plane, and

the one or more first material domains and the plurality of second material domains comprise a difference in one or more material properties from one another.

2. The polishing pad of claim 1, wherein

the plurality of second material domains are distributed in the side-by-side

arrangement with the one or more first material domains, and

at least one dimension of one or more of the plurality of second material domains is less than 500 μm when measured in the X-Y plane.

3. The polishing pad of claim 1, wherein the one or more material properties are selected from the group consisting of storage modulus E', loss modulus E", hardness, tan δ, yield strength, ultimate tensile strength, elongation, thermal conductivity, zeta potential, mass density, surface tension, Poisson's ratio, fracture toughness, surface roughness (Ra), glass transition temperature (Tg), and combinations thereof.

4. The polishing pad of claim 1, wherein a ratio of storage modulus between the first material domains and the second material domains is more than 1:2.

5. The polishing pad of claim 1, further comprising a plurality of pore forming features interspersed within the continuous polymer phase of polishing pad material.

6. The polishing pad of claim 1, wherein the continuous polymer phase of polishing material is formed by sequential repetitions of:

dispensing droplets of the first pre-polymer composition and droplets of the second pre-polymer composition onto a surface of a previously formed print layer; and

at least partially curing the dispensed droplets of the first pre-polymer composition and the dispensed droplets of the second pre-polymer composition to form a print layer.

7. The polishing pad of claim 6, further comprising a plurality of pore forming features interspersed within the continuous polymer phase of polishing pad material, wherein one or more of the sequential repetitions used to form the continuous polymer phase of polishing material further includes dispensing droplets of a sacrificial material or a sacrificial material precursor according to a droplet dispense pattern to form at least portions of the plurality of pore forming features.

8. A method of forming a polishing pad, comprising sequential repetitions of:

dispensing droplets of a first pre-polymer composition and droplets of a second pre-polymer composition onto a surface of a previously formed print layer according to

a predetermined droplet dispense pattern, wherein the first pre-polymer composition is different from the second pre-polymer composition; and

at least partially curing the dispensed droplets of the first pre-polymer composition and the dispensed droplets of the second pre-polymer composition to form a print layer comprising at least portions of one or more first material domains and a plurality of second material domains, wherein

at least partially curing the dispensed droplets at least partially co-polymerizes the first pre-polymer composition and the second pre-polymer composition at interfacial boundary regions disposed at adjoining locations of the first and second material domains to form a continuous polymer phase of polishing material,

the plurality of second material domains are distributed in a pattern the continuous polymer phase of polishing pad material, the pattern comprising:

(a) the plurality of second material domains disposed in a side-by-side arrangement with the one or more first material domains in an X-Y plane of the continuous polymer phase of polishing pad material, wherein at least one lateral dimension of one or more of the plurality of second material domains is less than 10 mm when measured in the X-Y plane;

(b) the plurality of second material domains disposed in an alternating stacked arrangement with the one or more first material domains in a Z plane of the continuous polymer phase of polishing pad material, wherein at least one dimension of one or more of the plurality of second material domains is less than 1 mm when measured in the Z plane; or

c) a combination of (a) and (b),

the X-Y plane is parallel to the surface of the previously formed print layer,

the Z plane is orthogonal to the X-Y plane, and

the one or more first material domains and the plurality of second material domains comprise a difference in one or more material properties from one another.

9. The method of claim 8, wherein least one dimension of one or more of the second material domains is less than 500 μm when measured in the X-Y plane.

10. The method of claim 8, wherein one or more print layers are formed to have a thickness of less than 200 μm.

11. The method of claim 8, wherein the one or more material properties are selected from the group consisting of storage modulus E', loss modulus E", hardness, tan δ, yield strength, ultimate tensile strength, elongation, thermal conductivity, zeta potential, mass density, surface tension, Poisson's ratio, fracture toughness, surface roughness (Ra), glass transition temperature (Tg), and combinations thereof.

12. The method of claim 8, wherein a ratio of storage modulus between the second material domains and the first material domains is more than 1:2.

13. The method of claim 8, wherein one or more of the sequential repetitions used to form the continuous polymer phase of polishing material further comprises dispensing droplets of a sacrificial material or a sacrificial material precursor according to a droplet dispense pattern to form at least portions of a plurality of pore forming features interspersed within the continuous polymer phase of polishing material.

14. An additive manufacturing system comprising a computer readable medium having instructions stored thereon for performing a method of manufacturing a polishing pad when executed by a system controller, the method comprising sequential repetitions of:

dispensing droplets of a first pre-polymer composition and droplets of a second pre-polymer composition which is different from the first pre-polymer composition onto a surface of a previously formed print layer according to a predetermined droplet dispense pattern; and

at least partially curing the dispensed droplets of the first pre-polymer composition and the dispensed droplets of the second pre-polymer composition to form a print layer comprising at least portions of one or more first material domains and a plurality of second material domains, wherein

at least partially curing the dispensed droplets at least partially co-polymerizes the first pre-polymer composition and the second pre-polymer composition at interfacial boundary regions disposed at adjoining locations of the first and second material domains to form a continuous polymer phase of polishing material,

the plurality of second material domains are distributed in a pattern, the pattern comprising:

(a) the plurality of second material domains disposed in a side-by-side

arrangement with the one or more first material domains in an X-Y plane of the continuous polymer phase of polishing pad material, wherein at least one lateral dimension of one or more of the plurality of second material domains is less than 10 mm when measured in the X-Y plane;

(b) the plurality of second material domains disposed in an alternating stacked arrangement with the one or more first material domains in a Z plane of the continuous polymer phase of polishing pad material, wherein at least one dimension of one or more of the plurality of second material domains is less than 1 mm when measured in the Z plane; or

c) a combination of (a) and (b),

the X-Y plane is parallel to the surface of the previously formed print layer,

the Z plane is orthogonal to the X-Y plane, and

the one or more first material domains and the plurality of second material domains comprise a difference in one or more material properties from one another.

15. The additive manufacturing system of claim 14, wherein least one dimension of one or more of the plurality of second material domains is less than 500 μm when measured in the X-Y plane.

16. The additive manufacturing system of claim 14, wherein one or more print layers are formed to have a thickness of less than 200 μm.

17. The additive manufacturing system of claim 14, wherein one or more of the sequential repetitions further comprises dispensing droplets of a sacrificial material or a sacrificial material precursor according to a droplet dispense pattern to form at least portions of a plurality of pore forming features interspersed within the continuous polymer phase of polishing material.