WHAT IS CLAIMED IS:

1. A porous ceramic matrix, the matrix comprising a plurality of ceramic particles adhered to each other, and a plurality of channels defined by surfaces of neighboring ceramic particles, the channels each having an average diameter of 0.5 - 2.5 μm, wherein the matrix features a porosity of 25.0 - 40.0 %, a Darcy's permeability of 1.57 - 34.8 x 10^{-14} m^2, and a mechanical strength of 25 - 64 MPa, wherein the channels include narrow segments, each of the narrow segments having a diameter smaller than 100 nm.

~~2. The porous ceramic matrix of claim 1, wherein the channels include narrow segments, each of the narrow segments having a diameter smaller than 100 nm.~~

~~3.~~2. The porous ceramic matrix of claim 1, wherein the ceramic particles are made of yttria, zirconia, alumina, aluminosilicate, silica, ceria, gadolinium-doped-ceria, magnesia, nickel-doped magnesia, zinc oxide, boron nitride, silicon carbide, silicon nitride, yttria-stabilized zirconia, lanthanum oxide, alkaline earth metal-doped lanthanum oxides, or a combination thereof.

~~4.~~3. The porous ceramic matrix of claim ~~3~~ 2, wherein the ceramic particles are made of yttria-stabilized zirconia.

~~5.~~4. The porous ceramic matrix of claim 4 3, wherein the channels include narrow segments, each of the narrow segments having a diameter smaller than 100 nm.

~~6.~~5. The porous ceramic matrix of claim 1, wherein the Darcy's permeability is 20 - 34.8 x 10^{-14} m^2 and the mechanical strength is 40 - 60 MPa.

~~7.~~6. The porous ceramic matrix of claim ~~6~~ 5, wherein the channels include narrow segments, each of the narrow segments having a diameter smaller than 100 nm.

~~8.~~7. The porous ceramic matrix of claim ~~6~~ 5, wherein the ceramic particles are made of yttria, zirconia, alumina, silica, ceria, gadolinium-doped-ceria, magnesia, nickel-doped magnesia, boron nitride, silicon carbide, silicon nitride, yttria-stabilized zirconia, lanthanum oxide, alkaline earth metal-doped lanthanum oxides, or a combination thereof.

~~9.~~8. The porous ceramic matrix of claim ~~8~~ 7, wherein the ceramic particles are made of yttria-stabilized zirconia.

~~10.~~9. The porous ceramic matrix of claim ~~9~~ 8, wherein at least one of the channels has one or more narrow segments each having a diameter smaller than 100 nm.

~~11.~~10. A method for preparing a porous ceramic matrix, the method comprising:

providing a ceramic pellet containing ceramic particles that are coated with a monomer, a catalyst, and a binder;

polymerizing the monomer in solid state by heating to form a polymer embedded in the ceramic pellets;

carbonizing the polymer, catalyst and binder to generate a porous ceramic pellet; and

sintering the porous ceramic pellet to form a porous ceramic matrix~~.~~;

wherein the monomer is 1 - 10 % by weight, the catalyst is 1 - 5% by weight, and the binder is 1 - 20 % by weight of the ceramic particles.

~~12.~~11. The method of claim ~~11~~ 10, wherein the ceramic particles are made of yttria, zirconia, alumina, silica, ceria, gadolinium-doped-ceria, magnesia, nickel-doped magnesia, boron nitride, silicon carbide, silicon nitride, yttria-stabilized zirconia, lanthanum oxide, alkaline earth metal-doped lanthanum oxides, or a combination thereof.

~~13.~~12. The method of claim ~~12~~ 11, wherein the ceramic particles are made of yttria-stabilized zirconia.

~~14.~~13. The method of claim ~~11~~ 10, wherein the monomer is acryl amide, terephthalic acid, p-phenylene diamine, p-hydroxybenzonic acid, 4, 4'-oxydiphthalic anhydride, 4,4'-diaminodiphenyl ether, 3,3'-diamino benzidine, 4,6-diamino-1,3-benzene-diol dihydrochloride, 2,5-diamino-1,4-benzenedithiol dihydrochloride, 3,3'-diamino benzidine, or a combination thereof.

~~15.~~14. The method of claim ~~11~~ 10, wherein the catalyst is ammonium peroxodisulfate, benzoyl peroxide, lithium chloride, beryllium chloride, hydrofluoric acid, boron trifluoride, aluminum chloride, or a combination thereof.

~~16.~~15. The method of claim ~~11~~ 10, wherein the binder is polyvinyl butyral, polyvinyl alcohol, poly(ethene oxide), acrylic polymers, cellulose ethers, methylcellulose, hydroxypropylmethyl cellulose, hydroxyethyl cellulose, or a combination thereof.

~~17.~~16. The method of claim ~~11~~ 10, wherein the polymer has an average degree of polymerization ranging from 5 to 100.

~~18.~~17. The method of claim ~~17~~ 16, wherein the polymer is polyacrylamide, poly(p-phenyleneterephthalamide), poly(p-hydroxybenzate), polyester, polyimide, polybenzimidazole, polybenzoxazole, polybenzthiazole, an aromatic ladder polymer, or a combination thereof.

~~19.~~18. The method of claim ~~18~~ 17, wherein the polymer is poly(p-phenyleneterephthal amide).

~~20.~~19. The method of claim ~~19~~ 18, wherein the ceramic particles are made of yttria-stabilized zirconia.

~~21.~~20. The method of claim ~~11~~ 10, wherein the carbonizing step is performed at 300 - 1000°C.

~~22.~~21. The method of claim ~~11~~ 10, wherein the sintering step is performed at 1000 - 1700°C.

~~23.~~22. A porous ceramic matrix prepared by the method of claim ~~11~~ 10.

~~24.~~23. A porous ceramic matrix prepared by the method of claim ~~20~~ 19.