Claims

[Claim 1] A composite yarn comprising a first yarn of bi-component filaments and a second yarn of homofilaments, wherein a majority of the first yarn is in an outer region of the composite yarn, the first yarn of bi-component filaments comprises polyethylene terephthalate and polyvinylidene difluoride, the second yarn of homofilaments comprises polyethylene terephthalate.

[Claim 2] The composite yarn according to claim 1 wherein the bi-component filament is produced as a side-by-side filament, a sheath-core filament, a matrix-fibril bicomponent filament, a segmented pie structure filament, a polymer blend filament.

[Claim 3] The composite yarn according to claim 2 wherein the bi-component filament is produced as the sheath-core filament with a core made of the first polymer and a sheath made of the second polymer.

[Claim 4] The composite yarn according to claim 3 wherein a ratio of a first number of filaments in the core to a second number of filaments in the sheath is 1:1 or higher.

[Claim 5] The composite yarn according to any one of claims 1 to 4 wherein the bicomponent filaments makes up 1 to 50 percent of the total number of filaments in the composite yarn.

[Claim 6] The composite yarn according to any one of claims 1 to 5 wherein the composite yarn is prepared as a cowraped yarn, a cotwisted yarn, or a cospined yarn.

[Claim 7] A membrane comprising a supporting structure and a polymeric membrane layer on the supporting structure, wherein the composite yarn according to any one of claims 1 to 6 is braided or woven to form the supporting structure, the polymeric membrane layer comprises polyvinylidene difluoride.

[Claim 8] The membrane according to claim 7 wherein a third yarn and the composite yarn is braided or woven to form the supporting structure.

[Claim 9] The membrane according to claim 8 wherein the third yarn comprises a fourth polymer, the fourth polymer selected from the group consisting of cellulose, polyamide, polyacrylonitrile, polyester, polyolefin. polypropylene, polyvinyl chloride, and their derivatives.

[Claim 10] The membrane according to any one of claims 8 to 9 wherein the composite yarn makes up 0 to 100 percent of a second total number of filaments in the supporting structure, excluding 0 percent and 100 percent.

[Claim 11] The membrane according to claim 10 wherein the composite yarn makes up 4 to 50 percent of the second total number of filaments in the supporting structure.

[Claim 12] The membrane according to any one of claims 8 to 11 wherein the polymeric membrane layer further comprises at least one selected from the group consisting of cellulose acetate, cellulose triacetate, polyether ether ketone, polyacrylonitrile, polyamides, polyethylene, polystyrene, polysulfone, polyvinyl chloride, derivatives of the preceding polymers, blends of the preceding polymers and co-polymers of the preceding polymers.

[Claim 13] The membrane according to any one of claims 8 to 12 wherein at least part of the polymeric membrane layer penetrates the supporting structure.

[Claim 14] The membrane according to claim 13 wherein the polymeric membrane layer penetrates to about one third to one half of a thickness of the supporting structure.

[Claim 15] The membrane according to any one of claims 8 to 14 wherein the membrane is a flat sheet, a tube, or a hollow fiber.

[Claim 16] A filtering membrane module comprising a plurality of membranes according to any one of claims 8 to 15 bundled together and potted with a resin.

[Claim 17] A method of forming a membrane, the method comprising:
braiding or weaving the composite yarn according to any one of claims 1 to 6 into a support structure; and

coating the support structure with a dope solution to form a polymeric membrane layer, the dope solution comprising a membrane forming polymer, the membrane forming polymer comprises polyvinylidene difluoride.

[Claim 18] The method according to claim 17 wherein the membrane forming polymer further comprises at least one selected from the group consisting of cellulose acetate, cellulose triacetate, polyether ether ketone, polyacrylonitrile, polyamides, polyethylene, polystyrene, polysulfone, polyvinyl chloride, derivatives of the preceding polymers, blends of the preceding polymers and co-polymers of the preceding polymers.

[Claim 19] The method according to any one of claims 17 to 18 wherein the dope solution further comprises an additive and a solvent, the additive being able to enhance or control the pore formation or the hydrophilicity of the polymeric membrane layer and the solvent is able to dissolve or partially dissolve the membrane forming polymer.

[Claim 20] The method according to claim 19 wherein the additive is selected from the group consisting of glycerol, polyethylene glycol (PEG), polyvinylpyrrolidone (PVP), water, and combinations thereof.

[Claim 21] The method according to any one of claims 19 to 20 wherein the solvent is selected from the group consisting of acetone, chloroform, cyclohexane, dichloroethane, dimethylacetamide (DMAc), dimethylformamide, dimethylsulfoxide,

formamide triethylphosphate, hexane, N-methyl-2-pyrrolidone (NMP), tetrahydrofuran, and combinations thereof.

[Claim 22] The method according to any one of claims 19 to 21 wherein the dope solution comprises 14 to 30 weight precent of the membrane forming polymer, 1 to 20 weight percent of the additive and 55 to 85 weight percent of the solvent.

[Claim 23] The method according to any one of claims 17 to 22 wherein coating of the support structure is done at a temperature of 50 to 90°C.

[Claim 24] The method according to any one of claims 17 to 23 further comprising allowing the coated support structure to pass through air; and entering a coagulation bath to form the membrane.

[Claim 25] The method according to claim 24 wherein the coated support structure passes through 30 to 200 mm of air.

[Claim 26] The method according to any one of claims 24 to 25 wherein the coagulation bath is at a temperature of 20ºC to 60ºC

[Claim 27] The method according to any one of claims 24 to 26 further comprising passing the membrane through a leaching tank.