CLAIMS

What is claimed is:

1. A method comprising:

heat treating an isotropic pitch composition comprising two or more aromatic classes linked with at least one methylene bridge between each aromatic classes, at a temperature of about 300°C to about 500°C to produce a mesophase pitch composition having a weight average molecular weight (Mw) of about 300 g/mol to about 2,000 g/mol, a softening point (T_{sp}) of about 100°C or greater, a mesophase content of about 0.01 vol% to 100 vol%, based on the total volume of the mesophase pitch composition, and a micro carbon residue (MCR) of about 25 wt% or greater, based on the total weight of the mesophase pitch composition;

wherein heat treating induces cyclization between at least two of the two or more aromatic classes to form one or more 5-membered rings and/or 6-membered rings.

2. The method of claim 1, wherein each one of the two or more aromatic classes are unsubstituted aromatics and/or substituted aromatics selected from the group consisting of 1-membered ring aromatics (ARC1), 2-membered ring aromatics (ARC2), 3-membered ring aromatics (ARC3), 4-membered aromatics (ARC4), 5-membered ring aromatics (ARC5), 6-membered ring aromatics (ARC6), 7-membered ring aromatics (ARC7), 8-membered ring aromatics (ARC8), 9-membered ring aromatics (ARC9), 10 or more-membered ring aromatics (ARC10+), and any combination thereof.

3. The method of claim 2, wherein the substituted aromatics are selected from the group consisting of C_1 to C_{20} hydrocarbyl monosubstituted aromatics, C_1 to C_{20} hydrocarbyl disubstituted aromatics, C_1 to C_{20} hydrocarbyl trisubstituted aromatics, and any combination thereof.

4. The method of claim 1, wherein cyclization between at least two of the two or more aromatic classes to form one or more 6-membered rings is followed by dehydrogenative aromatization to produce a highly aromatic mesophase pitch composition.

5. The method of claim 1, wherein the isotropic pitch composition is produced by:

mixing an aromatic feedstock comprising the one or more aromatic classes with acetic acid and sulfuric acid, to produce a first mixture;

heating the first mixture at a temperature of about 40°C to about 400°C;

adding formaldehyde and/or paraformaldehyde to the first mixture at a temperature of about 40°C to about 400°C to produce a second mixture comprising a reaction products composition;

filtering the second mixture; and

isolating the isotropic pitch composition.

6. The method of claim 1, wherein the isotropic pitch composition has a weight average molecular weight (Mw) of about 300 g/mol to about 2,000 g/mol, a softening point (T_{sp}) of 50°C or greater, and a micro carbon residue (MCR) of about 15 wt% or greater, based on the total weight of the isotropic pitch composition.

7. The method of claim 1, wherein each one of the two or more aromatic classes comprise partially hydrogenated aromatic rings.

8. The method of claim 1, wherein each one of the two or more aromatic classes are selected from the group consisting of benzene, toluene, xylenes (such as ortho-, meta-, para-xylene), naphthalene, 1-methyl naphthalene, 2-methyl naphthalene, anthracene, phenanthrene, pyrene, benzopyrene, picenecoronene, chrysene, tetracene, pentacene, triphenylene, corannulene, benzo[j]fluoranthene, Benzo[c]fluorene, perylene, benzo-perylene, ovalene, AROMATIC-200™, and any combination thereof.

9. The method of claim 5, wherein the molar ratio aromatic feedstock: formaldehyde equivalence is from about 10:1 to about 1:10.

10. The method of claim 5, wherein the molar ratio aromatic feedstock: formaldehyde equivalence is 1:3.

11. The method of claim 5, wherein the molar ratio aromatic feedstock: sulfuric acid is from about 1:0.001 to about 1:20.

12. The method of claim 5, wherein the molar ratio aromatic feedstock: sulfuric acid is 1:2.

13. The methods of claim 1, wherein the isotropic pitch composition comprises: 0.1 wt% to 100 wt% ARC1, 0.1 wt% to 100 wt% ARC2, 0.1 wt% to 100 wt% ARC3, 0.1 wt% to 100 wt% ARC4, 0.1 wt% to 100 wt% ARC5, 0.1 wt% to 100 wt% ARC6, 0.1 wt% to 100 wt% ARC7, 0.1 wt% to 100 wt% ARC8, 0.1 wt% to 100 wt% ARC9, 0.1 wt% to 100 wt% ARC10+, based on the total weight of the isotropic pitch composition.

14. The methods of claim 1, wherein the isotropic pitch composition comprises: 0.1 wt% to 100 wt% ARC1, 0.1 wt% to 100 wt% ARC2, 0.1 wt% to 80 wt% ARC3, 0.1 wt% to 50 wt% ARC4, 0.1 wt% to 50 wt% ARC5, 0.1 wt% to 25 wt% ARC6, 0.1 wt% to 25 wt% ARC7, 0 wt% to 10 wt% ARC8, 0 wt% to 10 wt% ARC9, 0 wt% to 5 wt% ARC10+, based on the total weight of the isotropic pitch composition.

15. The methods of claim 1, wherein heat treating is heat soaking and/or deasphalting that is carried out at a temperature ranging from room temperature to 280°C, at a pressure ranging from ambient pressure to 700 psi, and/or at a reaction time ranging from about 1 hour to 3 hours, wherein solvent used for deasphalting is selected from the group consisting of: toluene, heptane, or combination of the two at various ratios, and wherein heat treating is carried out at a pressure ranging from ambient pressure to 1,000 psi.

~~16. The methods of claim 15, wherein deasphalting is carried out at a temperature ranging from room temperature to 280°C, at a pressure ranging from ambient pressure to 700 psi, and/or at a reaction time ranging from about 1 hour to 3 hours.~~

~~17. The methods of claim 15 or 16, wherein solvent used for deasphalting is selected from the group consisting of: toluene, heptane, or combination of the two at various ratios.~~

~~18. The methods of claim 1, wherein heat treating is carried out at a pressure ranging from ambient pressure to 1,000 psi.~~

~~19.~~16. The methods of ~~any of claims 12 to 18~~ claim 12, wherein the mesophase pitch composition has a mesophase content ranging from about 40 vol% to about 100 vol%, based on the total volume of the mesophase pitch composition.

~~20.~~17. A fiber, an oxidized fiber, carbonized fiber, graphitized fiber, fiber web, oxidized fiber web, carbonized fiber web, or graphitized fiber web prepared using the mesophase pitch composition of any of the preceding claims.

~~21.~~18. A mesophase pitch composition comprising:

a weight average molecular weight (Mw) of about 300 g/mol to about 2,000 g/mol, a softening point (T_{sp}) of about 100°C or greater, a mesophase content of about 0.01 vol% to 100 vol%, based on the total volume of the mesophase pitch composition, and a micro carbon

residue (MCR) of about 25 wt% or greater, based on the total weight of the mesophase pitch composition;

wherein the mesophase pitch composition is produced from an isotropic pitch composition having two or more aromatic classes linked with at least one methylene bridge between each aromatic classes; and

wherein the isotropic pitch composition has a weight average molecular weight (Mw) of about 300 g/mol to about 2,000 g/mol, a softening point (T_{sp}) of 50°C or greater, and a micro carbon residue (MCR) of about 15 wt% or greater, based on the total weight of the isotropic pitch composition.

~~22.~~19. The mesophase pitch composition of claim ~~21~~ 18, wherein each one of the two or more aromatic classes are unsubstituted aromatics and/or substituted aromatics selected from the group consisting of 1-membered ring aromatics (ARC1), 2-membered ring aromatics (ARC2), 3-membered ring aromatics (ARC3), 4-membered aromatics (ARC4), 5-membered ring aromatics (ARC5), 6-membered ring aromatics (ARC6), 7-membered ring aromatics (ARC7), 8-membered ring aromatics (ARC8), 9-membered ring aromatics (ARC9), 10 or more-membered ring aromatics (ARC10+), and any combination thereof.

~~23.~~20. The mesophase pitch composition of claim ~~21~~ 18, wherein the isotropic pitch composition comprises: 0.1 wt% to 100 wt% ARC1, 0.1 wt% to 100 wt% ARC2, 0.1 wt% to 80 wt% ARC3, 0.1 wt% to 50 wt% ARC4, 0.1 wt% to 50 wt% ARC5, 0.1 wt% to 25 wt% ARC6, 0.1 wt% to 25 wt% ARC7, 0 wt% to 10 wt% ARC8, 0 wt% to 10 wt% ARC9, 0 wt% to 5 wt% ARC10+, based on the total weight of the isotropic pitch composition.