CLAIMS

What is claimed is:

1. A method comprising:

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

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

adding formaldehyde and/or paraformaldehyde to the first mixture at a temperature of 40°C to 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 300 g/mol to 2,000 g/mol, a softening point (T_{sp}) of 50°C or greater, and a micro carbon residue (MCR) of 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 unsubstituted aromatics and/or substituted aromatics comprise partially hydrogenated aromatic rings.

8. The method of claim 1, wherein each one of the two or more unsubstituted aromatics and/or substituted aromatics 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 10:1 to 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 1:0.001 to 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 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 12, wherein the mesophase pitch composition has a mesophase content ranging from 40 vol% to 100 vol%, based on the total volume of the mesophase pitch composition.

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 claim 1.

18. A mesophase pitch composition comprising:

a weight average molecular weight (Mw) of 300 g/mol to 2,000 g/mol, a softening point (T_{sp}) of 100°C or greater, a mesophase content of 0.01 vol% to 100 vol%, based on the total volume of the mesophase pitch composition, and a micro carbon residue (MCR) of 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 unsubstituted aromatics and/or substituted aromatics linked with at least one methylene bridge between each unsubstituted aromatics and/or substituted aromatics; and

wherein the isotropic pitch composition has a weight average molecular weight (Mw) of 300 g/mol to 2,000 g/mol, a softening point (T_{sp}) of 50°C or greater, and a micro carbon

residue (MCR) of 15 wt% or greater, based on the total weight of the isotropic pitch composition.

19. The mesophase pitch composition of claim 18, wherein each one of the two or more unsubstituted aromatics and/or substituted aromatics is 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.

20. The mesophase pitch composition of claim 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.