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(71) Applicant: **FPINNOVATIONS** [CA/CA]; 570, boul. St-Jean, Pointe-Claire, Québec H9R 3J9 (CA).

(72) Inventors: **ZHANG, Yaolin**; Apt 306, 3545 Chemin Sainte-Foy, Québec, Québec G1X 1T1 (CA). **KOUISNI, Lamfeddal**; 6167 Boul. Lavoisier, St-Léonard, Québec H1P 2Z2 (CA). **WANG, Xiang-Ming**; 2172 rue Dominique-Campagna, Québec, Québec G2G 2R7 (CA). **PALEOLOGOU, Michael**; 297 Alice Carriere, Beaconsfield, Québec H9W 6E5 (CA). **FENG, Martin W.**; 1941 West 62nd Avenue, Vancouver, British Columbia V6G 2P5 (CA). **BRUNETTE, Gilles**; 1067 Alma Aubin, Québec, Québec G1X 4V5 (CA). **HE, Guangbo**; 36-22800 Windsor Court, Richmond, British Columbia V6V 2X6 (CA).

(74) Agent: **NORTON ROSE FULBRIGHT CANADA LLP/S.E.N.C.R.L., S.R.L.**; Suite 2500, 1 place Ville-Marie, Montreal, Québec H3B 1R1 (CA).

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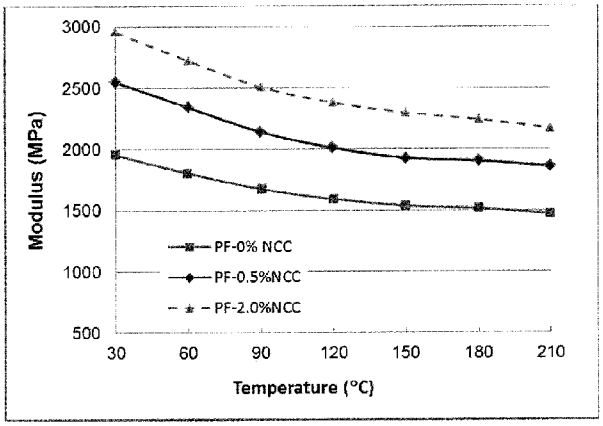

Figure 1

(57) Abstract: The present describes wood adhesives reinforced with cellulose nanocrystals (CNC), in liquid and powder forms in which resin system are a phenol-formaldehyde polymer and/or lignin-phenol- formaldehyde polymer and polymeric methylene diphenyl diisocyanate (p MDI), and a method of making this polymer in liquid and powder from and the composite products that can be produced therefrom.

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AMENDED CLAIMS
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CLAIMS:

1. A thermoset resin system for a wood adhesive comprising:

a thermoset resin,

a cellulose nanocrystal, and

30 to 60 % weight of moisture

wherein the cellulose nanocrystal is reinforcing the phenolic thermoset resin system,

comprising a weight ratio of hydroxide to phenol from 0.03:1 to 0.3:1.

2. The system of claim 1, wherein the thermoset resin is a phenolic powder for at least one of wood or molded products.

3. A powder thermoset resin system comprising

a phenolic component,

a formaldehyde component, and

a cellulose nanocrystals,

wherein the system comprises 2 to 8% weight of moisture per resin system.

4. The system of claim 3, wherein the system comprises from 4 to 6 % weight of moisture per resin system.

5. The system of claim 3 or 4, wherein the system comprises from 0.5 to 4% weight of cellulose nanocrystals per resin system.

6. The system of any one of claims 3 to 5, wherein the phenolic component is phenol.

7. The system of any one of claims 3 to 6, wherein the phenolic component is phenol and lignin.

8. The system of claim 6 or 7, comprising a molar ratio of formaldehyde : phenol component from 1.8:1 to 3:1.

9. A liquid thermoset resin system comprising

a phenolic component,

a formaldehyde component, and

a cellulose nanocrystals,

wherein the system comprises 35 to 55% weight of solids in the resin system, a % weight of moisture and the cellulose nanocrystals is incorporated into an intimate contact with the system, whereby the incorporation is through in-situ polymerization,

comprising a weight ratio of hydroxide to phenol from 0.03:1 to 0.3:1.

10. The system of claim 9, wherein the system comprises from 40 to 45 % weight solids per resin system.

11. The system of claim 9 or 10, wherein the system comprises from 0.5 to 1% weight of cellulose nanocrystals per resin system.

12. The system of any one of claims 9 to 11, wherein the phenolic component is phenol.

13. The system of any one of claims 9 to 12, wherein the phenolic component is phenol and lignin.

14. The system of claim 12 or 13, comprising a molar ratio of formaldehyde : phenol component of from 1.8:1 to 3:1.

15. A method of producing a liquid resin adhesive system comprising the steps of:

providing a phenolic compound;

providing a formaldehyde compound;

providing a cellulose nanocrystals;

providing an alkaline hydroxide;

mixing the phenolic compound and the cellulose nanocrystals with water and the alkaline hydroxide at a constant temperature making a phenolic blend;

methylolation of the phenolic blend by adding the formaldehyde compound to the phenolic blend to start the polymerization through condensation and controlling the temperature producing a reaction mixture; and

stopping the polymerization by cooling the reaction mixture until the mixture reaches a specific viscosity.

16. The method of claim 15, further comprising adding more formaldehyde and/or alkaline hydroxide to the reaction mixture during the polymerizing step.

17. A method for producing a powder resin adhesive system comprising the steps of "

providing a phenolic compound;

providing a formaldehyde compound;

providing a cellulose nanocrystals,

providing an alkaline hydroxide,

mixing the phenolic compound and the formaldehyde compound with water at a constant temperature making a resin mix having a specified solids weight % in the mix;

polymerizing the resin mix by adding the alkaline hydroxide to the resin mix to start the polymerization and controlling the temperature producing a reaction mixture;

monitoring and adjusting the temperature and pH of the reaction mixture;

stopping the polymerization by cooling the reaction mixture until the mixture reaches a specific viscosity and an alkaline pH to produce a phenolic resin,

mixing the cellulose nanocrystals with the phenolic resin and

drying the phenolic resin to produce the powder.

18. The method of claim 17, wherein the phenolic compound is at least one of phenol or lignin.

19. The method of claim 18, wherein the formaldehyde is a para-formaldehyde.

20. An oriented strand board or a plywood produced with the resin system defined in any one of claims 1 to 14.

21. A liquid thremoset resin system comprising:

a diisocyanate,

a cellulose nanocrystal

wherein the system comprises 40-60% weight of water content per resin system.

22. The system of claim 21, where the system comprises from 0.2% to 2% weight of cellulose nanocrystals per resin system

23. The system of claim 21 or 22, where the diisocyanate is polymeric methylene diphenyl diisocyanate (pMDI).

24. The system of claim 23, wherein the pMDI is an emulsifiable polymeric MDI.

25. The system of any one of claims 21 to 24, wherein the system comprises from 40-60% of diisocyanate per resin system.

26. The system of any one of claims 21 to 25, wherein the system is stable at least for one to three hours.