Calhoun

| U.S. Department of Agriculture<br>**Accomplishments Report AD-421**<br>U.S. Dept. of Agriculture, State Agricultural Experiment Stations and Other Institutions | | | Date (Month, Day, Year)<br>03/23/2012 |
|---|---|---|---|
| 1. Accession<br>0216470 | Agency Identification No.<br>2. SAES 3. LA.B | 5. Work Unit/Project No.<br>**LAB03940** | 6. Status<br>**Annual Report** |

7. Title

Detoxification of Spent CCA-treated Wood by Liquefaction and Reuse of Recovered Heavy Metals as Industrial Raw Materials

12. Investigator Name(s) (Last Name and Initials)

Pan, H.; Hse, C. Y.; Piao, C.; Marx, B.

| 20. Termination Date 12/31/2012 | 40. Period Covered (mo/da/year): 01/01/2011 TO 12/31/2011 |
|---|---|

Outputs:

Findings from this project were disseminated through five peer-reviewed journal articles, one proceedings, and one presentation at the 65th International Convention of Forest Product Society. A patent was issued on a process using rapid microwave assistance to detoxify CCA-treated wood. Specific outputs from this project include development of environmentally friendly and cost-effective recycling technologies for CCA-treated wood waste. Economic analyses were completed on the process of recycling CCA-treated wood waste to spray foam insulation and on the development of a novel lignin demethylation process to improve the reactivity of lignin as the replacement for petro-derived phenol in phenol-formaldehyde resin synthesis.

Outcomes/Impacts:

The costs of recycling of CCA-treated wood waste into spray insulation foam and a regenerated CCA treating solution was determined this year. The capacity of the recycling plant was estimated at 150,000 ton/yr. The annual output of bio-based polyurethane was estimated at 772,650 ton/yr (15% processing loss of total raw materials). Recovered CCA metals were estimated at 1,350 ton/yr (0.9% of CCA-treated wood waste, w/w). By taking into account savings from landfill tipping fees and the earnings from regenerated CCA treating solution, the unit price of the bio-based polyurethane is approximately $1,700/ton. If all the bio-based polyurethane is used for spray foam insulation at a density of 1.7 pcf and 1 in. thickness of the closed cell foam, the total spray area from 1 ton of bio-based polyurethane will be 15,600 ft2. The current market price for spray foam insulation is about $2.6/ft2; therefore, the gross earning from 1 ton bio-based polyurethane will be $40,560. Given the cost of bio-based polyurethane is about $1,700/ton, the profit margin indicated that recycling of CCA-treated wood waste into a spray foam and a regenerated CCA treating solution seems feasible and has potential to be economically viable. Six lignin compounds have been selected from a study of increasing lignin reactivity by demethylation reaction. The demethylation of different aromatic compounds was affected by the substitution groups on the aryl ring. An electron donating group, the hydroxyl group in our case, next to the target methoxyl groups had negative effects on demethylation reaction. Different solvent and catalyst combinations also had significant effects on the resulting products. Solvent N,N-dimethylformamide combined with strong bases, such as potassium butoxide and sodium methoxide, resulted in high conversion and yield of demethylated products. However, N-methyl-2-pyrrolidone combined with strong bases promotes numerous side reactions and has a low yield of demethylated products.

Publications:

Pan, H., Eberhardt T.L. 2011. Characterization of fly ash from the gasification of wood and assessment for its application as a soil amendment. BioResources 6(4): 3987-4004.

Pan, H., Zheng, Z., and Hse, C.Y. 2011. Microwave-assistant liquefaction of wood with polyhydric alcohols and its application to prepare polyurethane (PU) foams. European J. of Wood and Wood Products. Published online first. DOI 10.1007/s00107-011-0567-6.

Hu, L., Pan, H., Zhou, Y., Zhang, M. 2011. Methods to improve lignin's reactivity as a phenol substitute and as replacement for other phenolic compounds: A brief review. BioResources. 6(3): 3515-3525.

Pan, H., 2011. Synthesis of polymers from organic solvents liquefied biomass: A review. Renewable & Sustainable Energy Reviews 15: 3454-3463.

Via, B.K., O. Fasina, and Pan. H. 2011. Assessment of biomass density through mid-infrared spectroscopy and multivariate modeling. BioResources 6(1): 807-822.

Eberhardt TL, Pan H, Groom LH, So C-L. 2011. Characterization and partitioning of the char ash collected after the processing of pine wood chips in a pilot-scale gasification plant. In Proceedings of the International Conference on Woody Biomass Utilization, Starkville, MS. Edited by J. R. Shelly (Forest Products Society, Madison, WI); pp. 33-38.

Pan, H., Hu, L. 2011. Demethylation of lignin to improve its reactivity as a phenol substitute in PF resin synthesis. 65th International Convention of Forest Products Society, June 19-20, 2011. Portland, OR. (Abstract).

Participants:

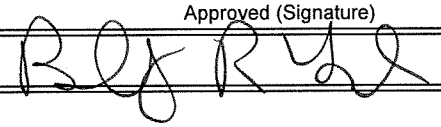
Hui Pan, (PI), Sang-yeob Lee, Lihong Hu, Jing Wang, and Xiaoqin Yang, LSU AgCenter.

Target Audiences:

Forest landowner, treated-wood industry, construction contractors, traditional forest products industry such as pulping and paper, future biomass refinery.

Project Modifications:

Nothing significant to report during this reporting period.

| Approved (Signature) | Title | Date |
|---|---|---|
|  | | |