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(54) **METHODS OF CONTROLLING THE HYDROPHILICITY OF CELLULOSE**

(58) **Field of Classification Search**
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See application file for complete search history.

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(56) **References Cited**

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U.S. PATENT DOCUMENTS

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- 2,759,787 A 8/1956 Touey et al.
- 4,260,740 A 4/1981 Carrington et al.
- 5,137,537 A 8/1992 Herron et al.
- 6,776,876 B1 8/2004 Vuorinen et al.
- 2003/0037891 A1 2/2003 Jewell
- 2007/0051481 A1 3/2007 Tan et al.
- 2011/0319509 A1 12/2011 Dorgan et al.
- 2015/0045549 A1 2/2015 Laukkanen et al.

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FOREIGN PATENT DOCUMENTS

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- EP 1827645 A1 9/2007
- WO WO-2006/066586 A1 6/2006
- WO WO-2014/070092 A1 5/2014
- WO WO-2016/183453 A1 11/2016

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OTHER PUBLICATIONS

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Cheng, Q. et al. Water Retention Value Measurements of Cellulosic Materials Using a Centrifuge Technique, *BioResources*, 5(3): 1945-1954 (2010).
International Search Report for PCT/US16/32381, 3 pages (Aug. 18, 2016).
Written Opinion for PCT/US16/32381, 7 pages (Aug. 18, 2016).

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(57) **ABSTRACT**

(52) **U.S. Cl.**

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In some embodiments, the present invention provides methods including the steps of providing cellulosic material, associating the cellulosic material with an organic acid (e.g., lactic acid) to form a mixture, and heating the mixture to a temperature between 100° C. and 120° C. for at least ten minutes to form a treated cellulosic material, wherein the water retention value of the treated cellulosic material is decreased by at least 10% as compared to untreated cellulosic material.

10 Claims, 10 Drawing Sheets