Blake A Simmons, J Fundam Renewable Energy Appl 2016, 6:3(Suppl)
http://dx.doi.org/10.4172/2090-4541.C1.008

Synthesis and characterization of renewable ionic liquids for biomass conversion

Blake A Simmons
Joint BioEnergy Institute, USA
Sandia National Laboratories, Livermore, USA

Ionic liquids (ILs), solvents composed entirely of paired ions, have been used in a wide variety of process chemistry and renewable energy applications. Imidazolium-based ILs show remarkable abilities to dissolve biomass, and are thus an ideal media for biomass pretreatment and depolymerization. Although very efficient, imidazolium cations are currently expensive and therefore their large scale use and industrial deployment, e.g. in biorefineries, is limited. In an attempt to replace imidazolium-based ILs with ILs derived from renewable sources that retain their efficiency for biomass pretreatment, we synthesized a series of tertiary amine based ILs from aromatic aldehydes derived from lignin and hemicellulose, the major byproducts of lignocellulosic biofuel production. A comprehensive analysis of extractable cell wall carbohydrates and sugar yields from switchgrass and switchgrass pretreated with tertiary amine based ILs derived from vanillin ([Van][H_2PO_4]), *p*-anisaldehyde ([*p*-AnisEt_2NH][H_2PO_4]) and furfural ([FurEt_2NH][H_2PO_4]) confirmed their effectiveness for biomass pretreatment. The amounts of sugar released by enzymatic hydrolysis of the cellulose present in switchgrass was comparable to that obtained after pretreatment with 1-ethyl-3-methylimidazolium acetate ([C_2C_1Im][OAc]). Enzymatic saccharification with [FurEt_2NH][H_2PO_4] and [*p*-AnisEt_2NH][H_2PO_4] provided 90% and 96% of total possible glucose and 70% and 76% of total possible xylose, respectively, after biomass pretreatment. Our concept of deriving ILs from lignocellulosic biomass shows significant potential for the realization of a "closed-loop" process for future lignocellulosic biorefineries, and has far-reaching economic impacts for other IL based process technology currently using ILs synthesized from non-renewable sources.

Biography

Blake A Simmons joined Sandia National Laboratories (Livermore, CA) in 2001 as a Senior Member of the Technical Staff after receiving his PhD from Tulane University. In 2007, he was one of the principal co-investigators of the Joint BioEnergy Institute, a ten year, $259M DOE funded project tasked with the development and realization of next-generation biofuels produced from non-food crops. He is currently serving as the Chief Science and Technology Officer and the Vice-President of the Deconstruction Division at JBEI, where he leads a team of 41 researchers working on advanced methods of liberating fermentable sugars from lignocellulosic biomass. He is also the Senior Manager of the Advanced Biomanufacturing Group at Sandia and serves as the Laboratory Relationship Manager for the Biomass Program. He has over 250 publications, book chapters, and patents. His work has been featured in the New York Times, BBC, the Wall Street Journal, the San Francisco Chronicle, Fast Company, and the KQED televised science program Quest.

basimmons@lbl.gov

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