Improvement of Hydrolysis Efficiency of Cellulose Using Ionic Liquids for Efficient Bioethanol Production

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Bioethanol is an eco-friendly energy resource based on glucose extracted from agricultural crops, such as corn. To avoid competition between bioethanol production and food production, we focused on harvesting cellulose from non-edible biomass such as scrap wood. Cellulose, the main component of the plant cell walls, is conventionally hydrolyzed to glucose using dilute sulfuric acid, but with low efficiency. We quantified glucose produced in the hydrolysis process by the phenol sulfuric acid method and compared different strategies for improving hydrolysis efficiency. First, we treated cellulose with 1-butyl-3-methyl imidazolium chloride ([C4mim]Cl), an ionic liquid that we synthesized, prior to hydrolysis with dilute sulfuric acid. Pretreatment yielded about 20% higher glucose than without pretreatment. Examination of the cellulose structure by X-ray diffraction showed that pretreatment with the ionic liquid converted cellulose I to cellulose II and reduced the average molecular weight, suggesting that these changes of the molecular structure result in increased glucose production efficiency. Next, we produced a solid acid catalyst, sulfonated activated carbon, to decompose the treated cellulose with the ionic liquid. In this method, the reaction temperature could be raised to 110 □C, which is higher than the temperature employed for the dilute sulfuric acid method. This method showed 32% higher glucose yield than the conventional method. Further, this ionic liquid does not volatilize and can be collected for reuse. With supplemental treatments, the efficiency of glucose production could be improved, thus reducing the cost of bioethanol production from cellulose.

Awards Won:

American Chemical Society: Certificate of Honorable Mention