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Short Communication

Selective conversion of cellulose to levulinic acid via microwave-assisted synthesis in ionic liquids

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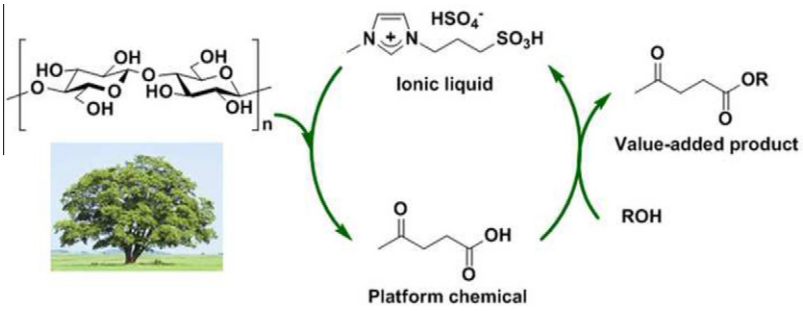
HIGHLIGHTS

- SO_3H-functionalized ILs selectively catalyzed cellulose conversion to levulinic acid.
- Microwave irradiation improved production of levulinic acid from cellulose.
- The highest yield of levulinic acid was 55.0%.
- Catalytic activities of SFILs depend on anions.
- Further esterification enabled product separation and SFIL recovery.

GRAPHICAL ABSTRACT



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ABSTRACT

A highly selective approach to produce levulinic acid from cellulose was developed via microwave-assisted synthesis in SO_3H-functionalized ionic liquids (SFILs). The effects of reaction conditions and ionic liquid structures on the yield of levulinic acid have been investigated, where the highest yield of 55.0% was obtained. The catalytic activities of SFILs depend on the anions and decrease in the order: HSO_4^- > $CH_3SO_3^-$ > $H_2PO_4^-$, which is in good agreement with their acidity order. The SFILs are efficient catalysts for cellulose conversion into levulinic acid and the subsequent esterification, which facilitates the separation of product and reuse of ionic liquids.

1. Introduction

Diminishing fossil resources and increasing concern about sustainable development have prompted the research on production of liquid hydrocarbon fuels and chemicals from biomass, which is the only renewable resource of fixed carbon (Ragauskas et al., 2006). As the most abundant biomass and sustainable raw materials, cellulose (Klemm et al., 2005) can be utilized to produce platform chemicals such as levulinic acid (LA) (Corma et al., 2007; Rackemann and Doherty, 2011), a versatile building block for fuel additives, polymer precursors, herbicides, pharmaceuticals, flavor substances and chemical intermediates. Recent work demonstrated that LA can serve as initial feedstock for existing petrochemical processing operations (Bozell, 2010), thus production of LA from cellulose has attracted considerable attention and become one of the key steps for the biomass refining. However, cellulose is generally regarded as a difficult material to work with due to its densely packed structure and insolubility in water (Jarvis, 2003). Various catalytic systems have been attempted to convert cellulose into LA directly, including mineral acids (Girisuta et al., 2007), metal chlorides (Seri et al., 2002), solid acid catalysts (Zakzeski et al., 2012) and acidic polymers (Vyver et al., 2011), whereas the limiting issues were focused on improving the selectivity of LA and developing efficient strategies for product separation and catalyst recovery.

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