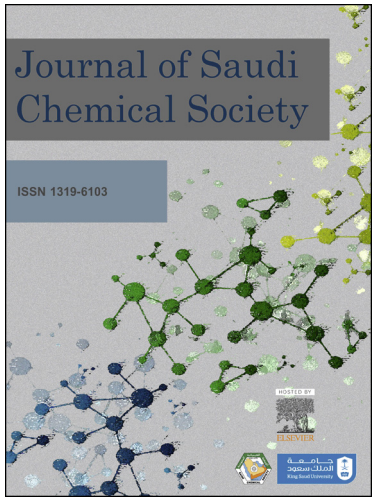

Original article

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Renewable Aromatics from the Degradation of Polystyrene under Mild Conditions

Nouf M Jabri,[a,b] Zhiping Lai,[a,c] Nikolaos Hadjichristidis,[a,b] Kuo-Wei Huang [a,b,*]

[a]Division of Physical Science and Engineering, King Abdullah University of Science and Technology, Thuwal 23955-6900, Saudi Arabia.

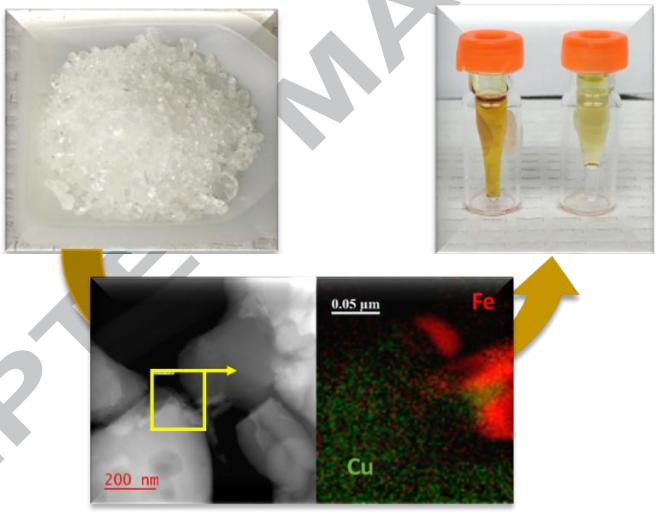
[b]KAUST Catalysis Center, King Abdullah University of Science and Technology, Thuwal 23955-6900, Saudi Arabia.

[c]Advanced Membranes & Porous Materials Center, King Abdullah University of Science and Technology, Thuwal 23955-6900, Saudi Arabia.

hkw@kaust.edu.sa

Abstract

A bimetallic FeCu/alumina catalyst was prepared and characterized. It showed excellent catalytic activity to quantitatively convert polystyrene (PS) into aromatics at low temperatures. A clear goldish yellow liquid was produced at 250 °C in a batch reactor without distillation. A liquid yield of 66% in an inert environment was achieved without the formation of coke and gas by-products. An exposure time of 90 min. and a catalyst loading of 200 mg were considered as an optimum condition to minimize the styrene re-polymerization. The gas chromatography/ mass spectrometry (GC/MS) analysis confirms that the primary products are styrene, ethylbenzene, cumene, toluene and α-methylstyrene.



Keywords: Polystyrene, bimetallic, low-temperature, catalytic degradation

1. Introduction

Plastic products play an important role in the modern life. As their production has increased to meet the market demand, their waste accumulation has created a serious environmental issues. Polystyrene (PS) represents 10 wt. % of the total plastic waste in which 15 million tons of PS is produced annually since 2008 [1,2]. There are four primary practices to handle the waste plastics, including landfilling, incineration, mechanical, and chemical recycling [3-6]. Currently, the oceans, seas, and rivers serve as sinks for the PS as well as other plastics debris [7]. PS represents 70% of overall marine debris plastics due to its poor recycling rate [7]. In fact, styrene monomer and other chemicals can leach out and get ingested by the marine life to eventually impact our food [8]. Importantly, such chemicals can be impregnated in the beach sands as well. Kwon and co-workers have collected different beach sand and seawater samples from Pacific Ocean, Alaska and Hawaii and showed that all the samples contained styrene monomer and dimer which are carcinogenic [9].

As polystyrene has high energy content, chemical and thermal degradation of PS are the best recycling approaches. It has been reported that exposing PS to high temperatures can generate high yields of styrene as illustrated by Nishizaki and co-workers [10]. In this process, the C-C bonds are cleaved via radical pathways [11]. However, the thermal depolymerisation at high temperature results in the coke formation, and