Synthesis & Application of Porous Polyolefin Films

By

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Abstract

The aim of this study is to develop multifunctional polymer films using polyethylene for energy and environmental applications. The first part is related to the preparation of super oil sorbent polymer (oil-SAP) sheets for efficient oil spill remedy while the second part is focused on the production of a novel composite electrolyte membrane for fuel cell applications.

Thermoplastics (such as polypropylene, polyethylene, polyethylene terephthalate (PET), high density polyethylene (HDPE) etc.) are significant components of municipal solid waste. A huge quantity of plastic waste is disposed of each year and is mostly either discarded in landfills or incinerated. On the other hand, the usage of synthetic polymers as oil sorbents, in particular, polyolefins, including polypropylene (PP), and polyethylene (PE) are the most commonly used oil sorbent materials mainly due to their low cost. However, they possess relatively low oil absorption capacities. Attempts at trying to increase the surface to thickness ratio for improving uptake capacity makes them vulnerable to breakage and impractical to be used in most oil spill applications. Besides the saturation contact time of these sorbents with oil is too long to be used in applications where the first few hours are crucial as the critical stage of spreading occurs within the first hour. In this work, we provide an innovative way to produce a value-added product such as oil-sorbent films from waste HDPE bottles for rapid oil spill remedy. In order to develop a novel process, we first prepared our oil-sorbent sample using virgin polyethylene powder to establish a bench mark and then to extend this study for waste HDPE bottles. The presented sorbent exhibits extremely high uptake capacity, excellent oil uptake speed and high mechanical strength. Moreover, dynamic dripping profile and kinetics modeling tests of the oil sorption are also provided. The experimental results show a good correlation with the pseudo-second order model.

A novel composite electrolyte membrane, consisting of polyethylene substrate and Nafion ionomer, was also manufactured. Nafion is by far the most widely used electrolyte in the fuel cell industry because of its excellent proton conductivity. Yet, it suffers from several drawbacks such as high fuel crossover and low mechanical strength, which lower the fuel cell performance and disturb the structural integrity. In order to deal with these problems, we have prepared an NPE (Nafion-polyethylene) composite that is composed of a porous substrate and a filling electrolyte. Nafion was used as a filling electrolyte and was impregnated into the pores of porous substrate made up of polyethylene. The polymer backbone serves as a structural support and blocks the crossover while the impregnated Nafion molecules provide the proton conducting path. Systematic characterization of NPE is also presented.

Date: 23 December 2014 (Tuesday)
Time: 10:00am
Venue: Room 4115A (Lift 19)

Examination Committee:
Prof. Yilong Han, Chairman
Prof. John Barford, Prof. Gordon McKay, Supervisor
Prof. David Hui, Prof. Richard Lakerveld, CBME
Prof. Xiangru Zhang, CIVL
Prof. Kaimin Shih(External), HKU

- ALL ARE WELCOME -