FABRICATION AND MODIFICATION OF BIOLOGICAL MATERIALS UTILIZING SHEAR FLOW SYSTEM

Abstract

Efficient mixing and reaction can promote the fabrication and modification processes to obtain the products with desired properties. A modified Taylor-Couette mixer, which can generate turbulent shear flow environment, was introduced to facilitate the production of biodegradable polymer particles and biorenewable materials. We developed a simple and fast single emulsion technique to fabricate hollow polymer particles by turbulent fluid flow. The process involves the one-step emulsification of a PLA-ethyl acetate solution in the water-glycerol medium under shear and the solidification of PLA particles by the diffusion of ethyl acetate to plenty of water. Turbulent regime and processing temperature were found as key factors to dynamic control the production of polymer particles from solid nanospheres to hollow microspheres. This method allows the easy control of polymer particle shape and size. Successful incorporations of hydrophilic iron oxide nanoparticles and a small peptide were introduced here as representative examples of its practical applications in the efficient encapsulation of hydrophilic materials in the hydrophobic polymer matrix for different demands.

We also reported a fast and high efficiency nanoscale hybrid pretreatment method of lignocellulosic biomass. Corn stover was pretreated in this mixer at a reduced temperature for two minutes with alkaline condition. Composition analysis showed the significant removal of both lignin and hemicellulose after the hybrid pretreatment. Microscopy images revealed the severe disruption of corn stover structure and exposure of cellulose microfibrils from the cell wall. Effective fractionation and structure disruption can be achieved by this method. In order to make the production economically feasible, cationic polyelectrolyte was firstly introduced as the additive in this pretreatment of corn stover. At room temperature and fast processing conditions (~ 2 minutes), lignin was found to redistribute on the inner and outer surfaces of the cell wall as lignin aggregate droplets instead of being extracted. Free nano-/microfibrils in the
residues were also observed. The yields of enzymatic hydrolysis were enhanced for the pretreated corn stover with the aid of polyelectrolyte. We speculate that lignin was effectively modified which opened up the cell wall structure during the short pretreatment process and prevented non-productive binding of enzymes in the enzyme hydrolysis reaction. This can improve cellulose accessibility and digestibility, indicating that polyelectrolyte is a promising alternative to modify the biomass surface and reduce the use of expensive enzymes.

Persons with disabilities have the right to request and receive reasonable accommodation. Please call the Department of Chemical Engineering and Materials Science at 355-5135 at least one day prior to the seminar; requests received after this date will be met when possible.