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ORIGINAL PAPER

Rapid synthesis of cellulose triacetate from cotton cellulose and its effect on specific surface area and particle size distribution

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Abstract A highly rapid process is described for the preparation of cellulose triacetate and its effect on particle size and surface area of the product. The process involves microwave-assisted rapid synthesis of cellulose triacetate with very low amount of acetic anhydride (10–15% of acetic anhydride is used in conventional methods) in the presence of iodine as a catalyst using a designed reaction vessel. The technique used is simple and rapid; it is also characterized by a high conversion ratio (yield 100%). A small amount of iodine (115 and 230 mg, 1.15 and 2.3% of cellulose weight) was found to be effective in the production of cellulose triacetate using 25, 30 to 40 mL acetic anhydride for 10 g cellulose under microwave irradiation for 2–4 min. The production of cellulose triacetate and the degree of substitution were confirmed by FTIR, Raman, ^{1}H NMR, and thermogravimetric analysis. The optimal reaction condition was discovered to be 3 min microwave radiation and 30 mL acetic anhydride in the presence of 230 mg iodine for 10 g cellulose. The effects of the amount of acetic anhydride, and amount of catalyst and reaction time on the specific surface area, pore volume, mean pore diameter, and particle size distribution were investigated. The highest surface area obtained was 39.63 m^2/g. The specific surface area and particle size distribution are highly dependent on the amount of acetic anhydride and I_2 catalyst. About 10% of the synthesized cellulose acetate showed particle size less than 200 nm.

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Introduction

The production of cellulose derivatives has attracted extensive interest worldwide, mainly due to its abundance in nature, biodegradability and low environmental impact in comparison with polymers obtained from fossil sources [1]. Wood pulp is typically used as a renewable resource to prepare cellulose acetate. Cellulose acetate, with degrees of substitution (DS) less or equal to 2.5, is biodegradable [2, 3]. Many types of cellulose esters are now produced commercially for different types of applications [3, 4].

Cellulose acetate is a cellulose derivative that is most important industrially. It has wide industrial applications such as cigarette filters, coatings, filtration membranes, textile fibers, consumer products, laminates, composites, and medical and pharmaceutical products [5–7]. Traditionally, cellulose acetate is produced from native cellulose, such as saw dust, sugar cane bagasse, and valonia cell using acetic anhydride and acetic acid in the presence of sulfuric acid as a catalyst [8, 9]. Recently, cellulose acetate was produced using ionic liquids as a solvent and super acids like SO_4^{2-}/ZrO_2 as a catalyst at room temperature [10, 11] as well as dialkylcarbodiimide, *N*,*N*-carbonyldiimidazole, aluminum chlorides [12] and iodine as catalysts for the esterification of cellulose in the presence of acetic anhydride [13]. Acidic ionic liquid can also be used to catalyze acetylation of cellulose as demonstrated by recent publications [14–16]. As the sulfuric acid has some effects on the environment, scientists try to find eco-friendly catalysts that can be used in the esterification process with no hazardous effects to the environment. The present paper focuses on the modification