Melting Processing of Biodegradable Cellulose Diacetate/Starch Composites

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Summary: Natural polymers and their derivatives are attracting increasing interest as promising biodegradable materials that can meet the environmental and recycling demands from society. This study prepared biodegradable composites of cellulose diacetate and starch, and examined their physical and thermal properties. In addition, the morphology of the composites was examined by scanning electron microscopy. For melt processing, epoxidized soybean oil, as a lubricant, and triacetine, as a plasticizer, were added to the composites. The optimal conditions for the preparation of the biodegradable composites were determined. Increasing the amount of starch in the composites resulted in further enhancement of the processability of cellulose diacetate. The tensile strength and Young’s modulus decreased, and the amount of elongation and Tg value increased with increasing amount of starch.

Keywords: cellulose diacetate; biodegradable; bio-composites; starch; triacetine

Introduction

Cellulose diacetate (CDA) is the most commercially important cellulose derivative that was recently demonstrated to be a biodegradable plastic.[1–5] However, this material has a high glass transition temperature (Tg) resulting in limited processibility compared with typical commodity plastics. In addition, it has low solubility in common solvents and is not melt processible because it decomposes before undergoing melt flow. Therefore, reducing the Tg and the flow temperature of CDA are important. The material needs to be plasticized in order to improve its thermal behavior and tensile properties.[6–8]

There has been significant interest in the utilization of starch as a biodegradable plastic material.[9,10] Next to cellulose, starch is the second most abundant renewable polysaccharide in nature.[9] Starch is not a true thermoplastic. However, it readily melts and flows in the presence of plasticizers, at high temperature (90–180 °C) and under shear, which can allow for its use as an injection or extrusion material in a similar manner to most conventional synthetic thermoplastic polymers.[11] Native starch suffers from a lack of moisture and abrasion resistance,[12] and it is normally used in combination with polar synthetic polymers.[13,14]

The preparation and characterization of a melt processable plasticized cellulose diacetate (CDA) using triacetin (TA) as a plasticizer has previously been reported.[15,16] The processability of the plasticized CDA was further enhanced using a small amount of epoxidized soybean oil as a secondary plasticizer. The Tg of the plasticized CDA was observed at 50 °C lower than that of the pure CDA, and the incorporation of 5 % of ESO also resulted in an additional 20 °C decrease in the Tg. In this study, various levels of cornstarch were added to the plasticized CDA containing TA and ESO. The processability and mechanical properties of the CDA/starch composites were examined as function of the starch content.